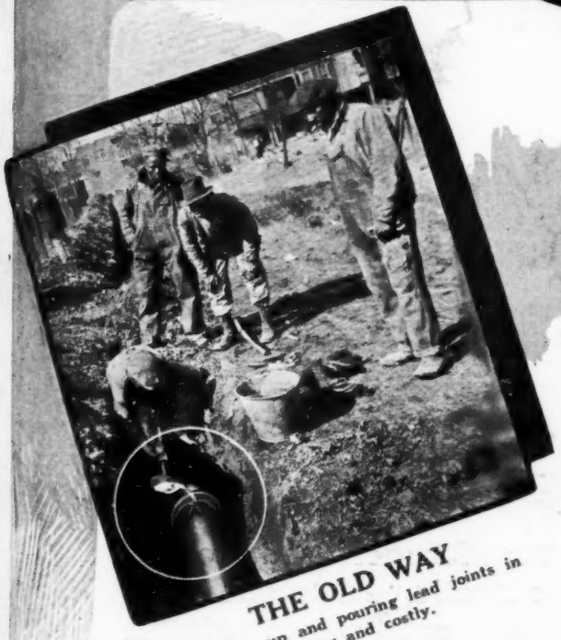
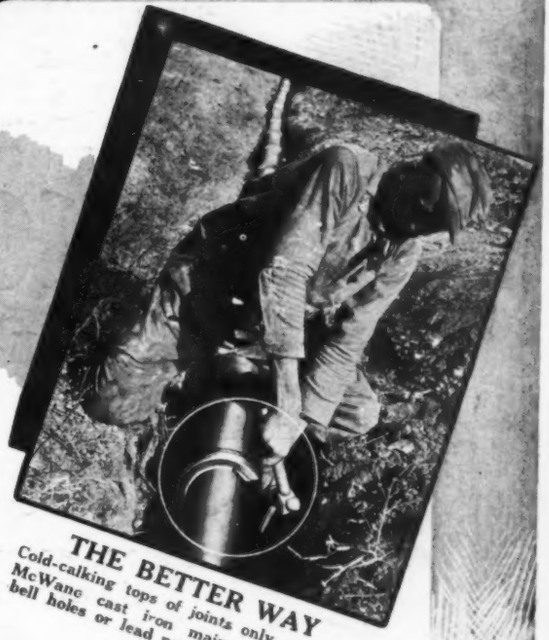
McWane Cast Iron Pipe

PRECALKED JOINT PIPE



THE OLD WAY

Making up and pouring lead joints in the trench—slow and costly.



THE BETTER WAY

Cold-calking tops of joints only. A 6-inch McWane cast iron main being laid—no bell holes or lead pouring.

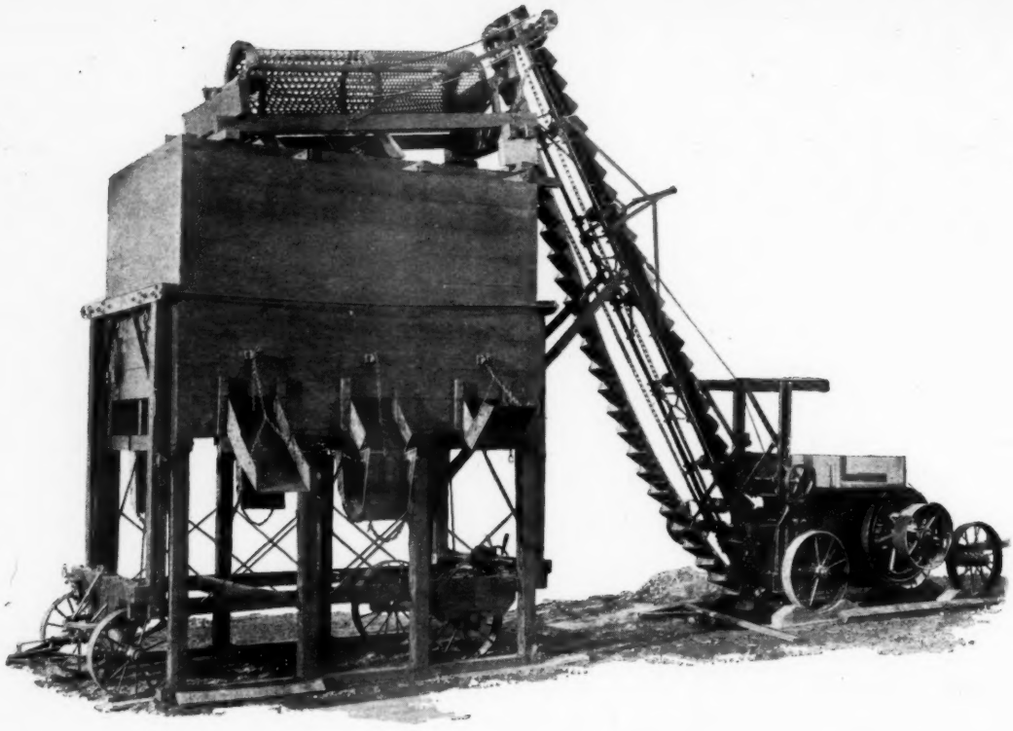
Eliminates all bell-holes, yarning and lead-pouring in the trench. It can be laid three times as rapidly as ordinary cast iron pipe, or for one-third the labor cost.

Used and constantly being reordered by leading water departments, industries, and railroads of America. Sizes as small as 1¼ and 2-inches, and up to 6-inches in diameter.

Write for booklet P, and free models.

McWane Cast Iron Pipe Company

Birmingham, Alabama



Continuous Crushing

Unlike those in all other jaw crushers, which are only actually crushing 50% of the time, the jaws in the Western-Aurora Crusher are never idle. While the top half opens to grasp new stone, the bottom half closes, and vice versa. Yet there is no dead center.

This feature is alone enough to account for increased production, and lessened operating costs and wear and tear; but there are others almost equally important.

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CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 54 May, 1923 No. 5

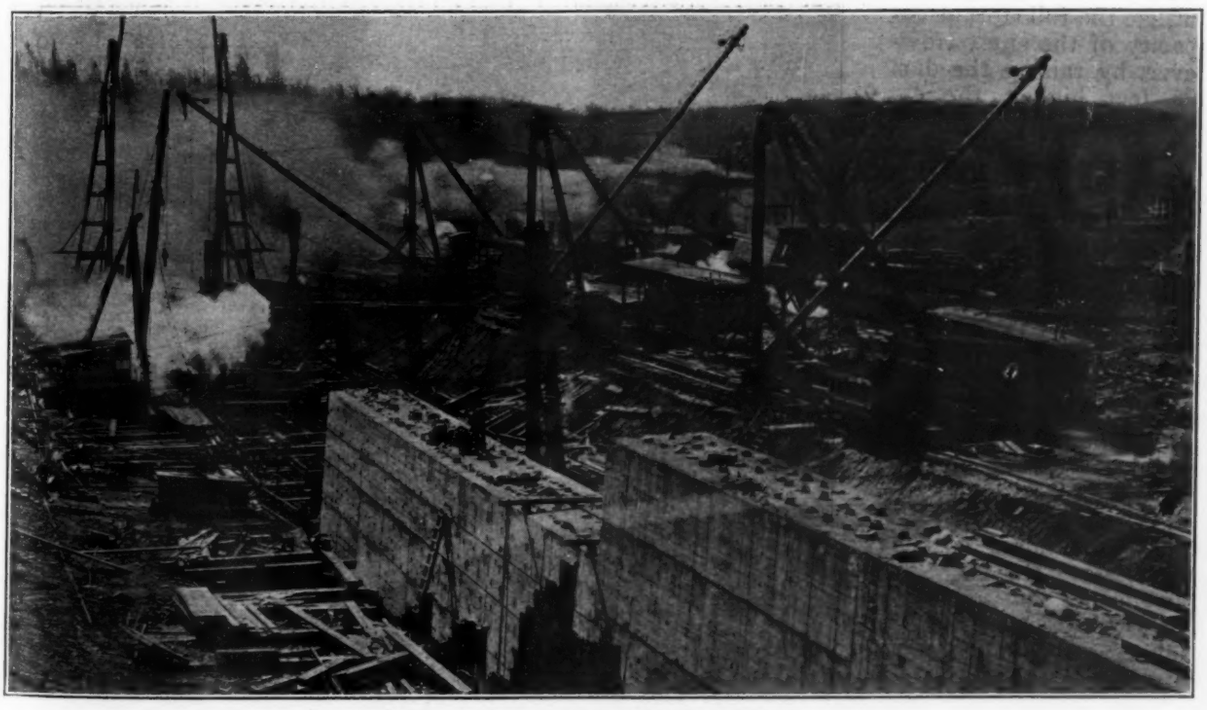
Progress on the Wanaque Project

Dam and twenty-five miles of aqueduct, including tunnels, to provide water for Newark and other municipalities in northern New Jersey. Unusual features in sheet piling and trench dewatering. Mucking by machinery in a nine-foot tunnel.

A water supply for the city of Newark, New Jersey, and, it is expected, for a number of other communities in northern New Jersey, is being developed by the North Jersey District Water Supply Commission by the impounding of the Wanaque river at a point about 25 miles north of Newark. This project was described in our issue of April 17th, 1920, and the beginning of the construction of the dam in our issue of August 7th, 1921.

Briefly, the project includes the construction, in the vicinity of Midvale, New Jersey, across the Wanaque river, with a water shed above the dam of 67.3 square miles, of a dam, and a conduit from this dam to connect with the existing conduit to Newark from its Pequannock supply, which is derived from a watershed a few miles west of the Wanaque shed. Provision will also be made for conduits leading to such other communities as may decide to use this supply.

The conduit will be carried in a general southerly direction from the Wanaque dam, following approximately the contour of the ground until it reaches Watchung Mountain near Great Notch, where it will pass through the mountain in a tunnel. The time required to construct the tunnel makes this a deciding feature in the completion of the entire



CORE WALL UNDER CONSTRUCTION.

Shows bonding stones on top of concrete; steel sheet-piling in foreground; derricks for handling sheet-piles and other material.

STEEL SHEET-PILING FORMING WATER-TIGHT CONTACT WITH ROCK 90 FEET BELOW GROUND SURFACE.

project and it was, therefore, decided to begin this as soon as possible and a contract for it was let last October and construction is now well under way, and the contract calls for its completion within 44 months after notice to begin work, or by July, 1926.

Owing to the uncertainty as to the number of municipalities that will associate themselves with the enterprise and use the water derived therefrom, certain of the features have not yet been finally decided upon. One of these is the height to which the dam will be raised. If only Newark uses the supply, provision for only 10,000,000 gallons a day will be necessary and the dam will not be raised to utilize the full storage capacity of the site. However, by raising the dam 25 feet higher, the capacity can be more than doubled and it would seem to be unfortunate if it is not possible to utilize this full capacity when doing so will necessitate such relatively slight increase in cost.

In view of the possible demands and the fact that it would cost almost, if not quite as much, to build a smaller tunnel as to build one with a capacity of 90,000,000 gallons a day, and in view of the great additional cost of duplicating the tunnel at any future time, one with this capacity was decided upon and is under construction.

The description of the construction of the dam in our issue of August 27, 1921, told of the driving of the sheet piles to a depth of nearly 100 feet, which is one of the very unusual features of this dam. The core wall has now been completed to a point about 20 feet above the ground surface and a part of the embankment has been carried up to the same height, and, except for some gravel filling work on the dam, has been discontinued for the time being until final determination has been made of the final height to which it is to be carried.

STEEL SHEET PILING

The engineers and contractor were naturally interested to learn, after the earth had been excavated between the two rows of sheet piling, how successful the driving of this had been in maintaining the sheeting vertical and in making good contact with the rock. It was found that the deviation from the vertical at the rock did not exceed 6 inches one way or the other, which was certainly as close as could be expected for piling driven 50 to 90 feet through coarse gravel. On top of the rock the slope of the ledge surface forced the piling out of line in places so that the trench, which was 20 feet wide at the top, varied from 18.6 to 24.4 feet at the rock surface. In general, the contact of the steel piling with the rock surface was found to be most satisfactory. In a few places the piles had encountered fragments of rock near the bottom and had been twisted out of their interlock and a few piles had apparently been overdriven and turned up or "fish-hooked" at the bottom. A few of the piles did not show tight contact and a small pile hammer was rigged on a derrick and such piles were driven to satisfactory contact. Those that turned up at the bottom were cut off with a torch. For a stretch of about 20 feet

CORE WALL TRENCH 100 FEET BELOW GROUND SURFACE.
Showing heavy timber bracing and large quantities of water in bottom of trench.

BLIND DRAIN DISCHARGING ALONG CENTER LINE OF CORE WALL.

on one side in the deepest section an additional set of short piling was driven inside the original set, but this was the only place where a double set was required.

The pressure against the piles was very great and was considerably increased by the ground water, but was reduced as described further on. The water tightness of the sheet piling held the ground water level at places 20 feet higher than the trench bottom and, in fact, it was necessary to open holes in the bottom of the sheet piling when it was desired to allow the ground water to escape into the trench.

As fast as the trench was excavated, the sheeting was supported by using 12 x 12-inch braces in bays spaced 10 feet on centers and with wales spaced 6 feet apart vertically for the upper 32 feet of the trench. Below this depth the spacing was at first reduced to 3 feet vertically, which was subsequently altered to double sets spaced at 6 feet, and here 14 x 14-inch rangers and 12 x 14-inch braces were used. After the trench had been excavated about 40 feet, the bracing began to show strain. One wale cracked longitudinally in about the middle and some of the braces cut into the wales as much as one-half inch and some of them split at the ends. The recurrence of this was prevented by substituting oak for pine bearing plates at the ends of the braces, and by framing the braces with even greater care so as to be sure that the entire end of the brace had a bearing on the bearing plate. Later, with the lowering of the ground water, the pressure decreased considerably and most of the braces when removed were cut out with no great difficulty and some were pulled out by a derrick without any cutting.

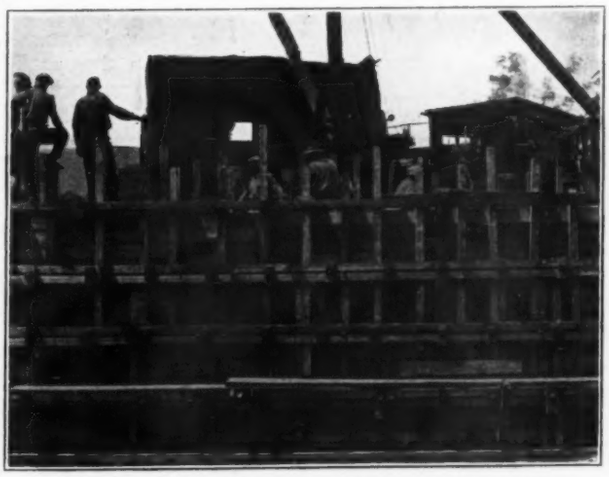
In driving the piles, the typical gang consisted of one foreman, one pile driver operator and six pile driver men for each rig, two rigs being run under one general foreman. High pressure steam was supplied from a central plant and no fireman was needed with the driving rig. The two rigs combined reached a maximum of 15,800 feet of sheet piling driven in one month, the minimum being 100 feet in January of 1922. The total amount driven in fourteen months of driving was 99,900 feet.

After the completion of the work an effort was made to draw and salvage some of the steel sheet piling. It was calculated, however, that the cost of this was greater than the value of the steel recovered, and the rest of the sheet piling was cut off with a torch at the surface of the ground.

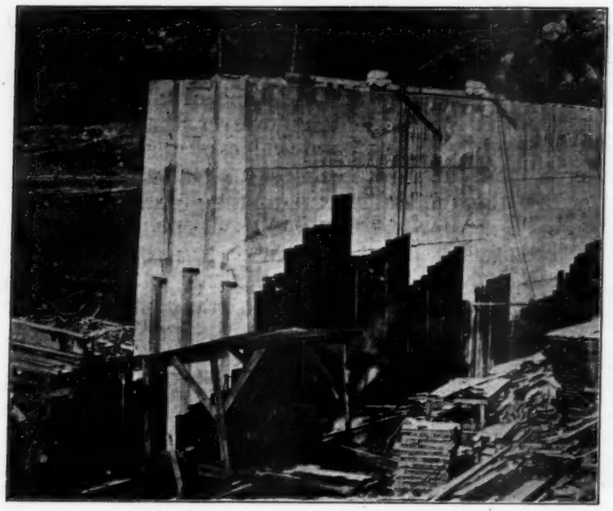
HANDLING GROUND WATER

Excavation inside the trench was begun at the north end with clamshell buckets operated from stiff-leg derricks running on a track on top of the west bank. (As described in the previous article, a wide trench was dug along each side of the core wall to a depth of about 10 or 12 feet and leveled off, giving a level path upon which to build the frame for guiding the piles and the pile driving rigs). Ground water was encountered immediately after the installation of the top set of bracings. Two 8-inch centrifugal dredge pumps, 60 inches in diameter, manufactured by the Morris Machine Company, were installed and, in addition to pumping water, removed a considerable yardage of sand and gravel from the trench, depositing it as part of the embankment on the downstream side of the dam. In addition, there were installed for handling the ground water, four No. 9 pulsometers, two 5-inch Emersons, two 5-inch Lawrence electric centrifugals and one 6-inch Westinghouse electric centrifugal. The amount of water removed was measured by a weir set in the trench by which the water was led to the river, and varied from a minimum of 200,000 gallons during the month of May to a maximum of 138,900,000 during August, 1921. In June, 1922, there was still being pumped 114,400,000 gallons, but this fell off rapidly with the completion of the core wall to 19,200,000 in August. During February, 1922, rates of 5,000 to 6,000 gallons per minute were pumped, when the longest stretch of deep trench was open.

In general, the ground water level remained about 20 feet above the level in the trench, resulting, as previously stated, in enormous pressure on the trench bracing. More or less water entered through seams in the rock. While working in the shallow trench



TYPICAL SECTION OF CORE WALL FORMS.



VERTICAL JOINT IN CORE WALL.

the water in the bottom was handled with no difficulty by means of blind drains or pipes close to the sheeting, but as the trench became deeper the quantity became greater so as to interfere with the placing of the concrete, and the ground water back of the sheeting began to leak through and flow onto the concrete at a point about 20 feet above the bottom of the trench. In order to prevent this, the ground water was lowered by burning holes in the sheeting near the bottom and driving through the sheeting, horizontally into the earth, 2-inch pipes pointed and perforated and three or four feet long. These permitted the ground water to drain away into the trench and most of the water entering the trench then came though these bleeder pipes and could be easily controlled.

When it came to placing concrete in the deepest sections, additional precautions were employed. The concrete was placed in stretches 10 to 20 feet in length and before placing that in the bottom of a new section, a concrete bulkhead or longitudinal wall 6 inches thick and 2 feet high was built two feet away from each line of sheeting. Between this wall and the sheeting a blind drain or pipe, sometimes connected with the bleeder pipes, was laid and carried the water to the pumps and away from the section under construction. The space between the two longitudinal bulkheads was then dry and the concrete could be placed there readily, and when it reached the top of the bulkheads, the space back of them was filled with concrete.

When concreting had been carried on in this way almost up to the main pumping plant, in the deepest part of the excavation, operations were begun near the other end, at a point where there was a natural sump in the rock, at which point another pump was installed, and the concrete was carried backward toward the main pumping plant.

It then became necessary to make the closure at this point, where a space about 40 feet in length had been left. Here longitudal parapet walls were built as described and the water which came underneath the sheet piles or through the bleeder pipes was thus concentrated between the parapets and the sheeting. The center wall was started between these parapets and carried to a height of about 6 feet, when the spaces between the concrete and the steel piling was filled with rock fragments and the top was sealed over with concrete extending from one wall of sheet piling to the other. Vertical pipes were carried up from the rock fragments at the bottom through the concrete to serve as pump suctions and the water was kept pumped down; the pumps being set slightly above the concrete already in place and raised from time to time as the concrete rose. By the time the concrete in this deep section had been completed, all of the other core wall concrete had been poured, pumping being continued until the last batch had been brought above ground water level.

CONCRETE WORK

The concrete was composed of gravel and sand obtained from a gravel bank about a half-mile away, where it was excavated by steam shovel, crushed and screened and hauled direct to the concrete mixer or stored for future use. The concrete mixing plant consisted of two Ransome mixers, size 53, located 300 feet from the core wall trench. The mixture was 1:21/2:5 and was deposited by the mixer into bottom-dump buckets, which were hauled to the core wall trench on narrow-gauge flat-cars and transferred to the forms by stiff-leg derricks. In placing the concrete in the deeper portions, it was deposited in hoppers feeding into vertical 10-inch steel pipe in order to prevent interference of the trench bracing.

Vertical joints between sections of concrete were made with tongue-and-groove. For binding at the horizontal joints, stones from 4 to 12 inches across were set into the top surface of the concrete. That these formed a perfect bond has been demonstrated during the past winter. At two or three places during the cold weather fine cracks have formed in the exposed top of the wall at points about midway between the construction joints, and these cracks have extended from one section to another across the horizontal construction joints. It is suggested that it might be preferable to substitute for these stone-bonded joints a tongue-and-groove joint similar to that used in the vertical construction joint. thus allowing a slight play of one section on the other. However, when the embankment has been placed against both faces of the core wall, and especially when the reservoir has been filled, it is not to be anticipated that there will be any appreciable temperature movements.

EMBANKMENT

After cutting off the sheeting and bringing the core wall above the elevation of the bottom of the trench, this trench was filled, the material on the upstream side consisting of clayey loam mixed with a considerable percentage of sand and gravel, while that on the downstream side was sand and gravel with no attempt at imperviousness. The impervious embankment on the upstream side was placed in layers about 6 inches deep and was thoroughly rolled and was found to compact to 3½ or 4 inches. This compacted material was carried up temporarily to the level of the ground surface and will be con-

tinued to the top of the core wall as the embankment construction proceeds.

The sand and gravel on the downstream side is being placed by hauling the material from borrow pits about one-half mile away, over narrow-gauge track with dinky engines, dumping the material on the embankment alongside the track and slushing it to place by means of water rather than moving it by hand or by scraper or dragline. Two men, using a 1⅛-inch nozzle can slush the dumped material down the embankment, which has a slope of about 3:1, as fast as a 3-car train can supply the material. At first, pumping the gravel onto the embankment from the borrow pit by the hydraulic method was tried, but it was found that hauling it by train and slushing by nozzle was cheaper. The surface water used in slushing the gravel into place flows off to the river through a trench. The embankment, although probably not impervious, as it is not intended to be, is thoroughly compacted and will undoubtedly experience no future settlement.

Unfortunately, the only fine material of the kind needed for the upstream side of the dam that could be found in the vicinity was located on the opposite side of the dam, while the gravel used for embankment on the downstream was located upstream from it. This made it desirable to leave an opening in the core wall from the ground level up, through which the embankment material could be carried. This opening will, of course, be filled before the embankment is carried much higher.

The river control conduit at the dam and the work on the tunnel will be described in the next issue. For the information used in this description we are indebted to Major A. H. Pratt, chief engineer, and N. C. Holdredge, assistant chief engineer, for the *Commission; and, for the photographs, to Major Pratt and the Commission.*

Cost of Placing Stone on Road

By Rodman Wiley *

NOTE—The following estimate was prepared by Mr. Wiley and published in the "Scraper" the journal of the Kentucky Association of Highway Engineers, at the invitation of the secretary of the association, D. R. Lyman, that contractors furnish analyses of costs of the different pieces of contract work in that State. Mr. Lyman has expressed in the "Scraper" his opinion that if actual figures could be obtained, it would be shown that the averages of all highway contracts in that State during 1921 *and* 1922 *would show practically no profit and might even show a loss.*

CONDITIONS

Suppose that no quarry has been opened but that good limestone is available under a 9-foot overburden and that a 15-foot face is the most practicable to work.

The quarry will be located one-fourth of a mile

*Contractor, Wincester, Kentucky.

FILLING TRENCH ALONG COMPLETED CORE WALL.
Slushing gravel to place on the right (down stream) side; rolling impervious material at the left.

off the road to be built, necessitating the building of a truck road at the contractor's expense.

The royalty on stone is 5 cents per ton.

There is no water at the quarry site but it can be pumped from a creek one-fourth of a mile distant.

The average haul on stone is 4 miles.

The road to be improved is an old, worn-out macadam, with steep grades. It is necessary to eliminate the grades so that the macadam road is converted into an earth road for 50 per cent. of its length. Therefore the average haul will be 2 miles over worn-out macadam and 2 miles over earth road.

The quantity of stone to be crushed is 30,000 tons.

It is necessary to use imported labor, which, when all things are considered, will cost the contractor $3 per day.

The nearest railroad station to the quarry site is 10 miles.

It is considered that the crusher is up to date, with a capacity of 300 tons per day. The engine is to have sufficient capacity to run the crusher and air compressor. Cars and track to be used for delivering stone to the crusher.

The quarry is to be stripped with wheelers on an average haul of 600 feet for the earth removed.

ESTIMATE

Stripping—For every 3 cubic yards of overburden removed, 5 cubic yards of stone will be exposed. One cubic yard of stone in the solid weighs about 4,300 pounds. Five cubic yards of stone will weigh 21,500 pounds or 10¾ tons, therefore for every ton of stone taken out 0.28 cubic yards of earth must be removed. It will cost about 80 cents per cubic yard to strip. The cost per ton for stripping will be 0.28 x 80 cents = 22 cents.

Move In and Set Up—

Dismantling quarry equipment and loading, about	$300
Freight, about	500
Unload and move to job 10 miles	400
Set up (including scales)	600
Total	$1,800

Which for 30,000 tons is 6 cents per ton.

Building Road to Crusher—Road one-fourth mile long and 10 feet wide with stone 12 inches deep, including the grading, will cost about $2,000. This for 30,000 tons is 6 cents per ton.

Daily Quarry Cost—

Foreman	$10.00
Engineer	5.00
Drill Runner	5.00
Helper	4.00
Two feeders at $3.50	7.00
Hoist runner	3.50
Pump man	3.50
Blacksmith	5.00
Mule and driver to pull cars to foot of incline	4.00
Man to hook cars	3.00
Water boy	2.00
Five cars in quarry, 7 men to a car loading and sledging equals 35 men at $3.00	105.00
Coal and oil	15.00
Total	$172.00

This outfit will produce an average of 250 tons per day. $172 ÷ 250 = 69 cents per ton.

Cost in Bin—

	Per Ton
Stripping	$0.22
Move in and set up	.06
Building road	.06
Daily quarry cost	.69
Explosives (½ lb. per ton)	.12
Interest on investment, $15,000 at 6 per cent. is $900. This for 30,000 tons is	.03
Depreciation, 20 per cent. is $3,000, which for 30,000 tons is	.10
Total in bin	$1.28

Cost in Place on Road—

	Per Ton
Cost in bin	$1.28
Dressing subgrade, building berms, about $600 per mile, figuring 6,000 tons per mile	.10
Hauling 4 miles (2 miles over earth, 2 miles over worn-out macadam) at 40 cents per ton mile	1.60
Spreading, watering and rolling	.40
Royalty	.05
Interest on equipment, $20,000 at 6 per cent. is $1,200, which for 30,000 tons equals	.04
Depreciation, 20 per cent., is $4,000, which on 30,000 tons equals	.13
Bond	.06
Insurance	.10
Overhead — Superintendent, timekeeper, office, traveling expense, use of automobiles, interest on borrowed money etc. ,about 5 per cent.	.20
General repairs	.10
Actual cost	$4.06

No profit included.

Montana's Highway Policy

The policy of the Montana Highway Department has been set forth at some length in the official organ of the department, "Montana Highway News." The salient features of this policy are given in abstract as follows:

What the Highway Department Proposes to Do

1. Take over the maintenance of the entire trunk highway system comprising 4,700 miles of road and pay all the cost of such maintenance.

2. Match Federal funds with the counties on a 27-20 per cent. basis, the counties supplying only 20 per cent. The Federal Government will supply 53 per cent.

3. Offer $225,000 to the counties annually as State Aid, same to be matched with county funds for improving important highways without Federal Aid.

How the Necessary Funds Will Be Secured

1. By an increase in motor vehicle fees, a two-cent gasoline tax, and revenue from royalties from Federal oil lands, as at present. There will be no general road levy on property for State road purposes.

What the Revenue Will Amount To

1. From motor vehicle registration fees, $1,200,000; from the gasoline tax, $500,000; from Federal oil royalties, $50,000; total, $1,750,000.

How the Money Will Be Spent

1. $705,000 will be spent in the maintenance of the 4,700-mile trunk system.

2. $600,000 will be matched, with $440,000 of county money against Federal Aid enabling the construction of $2,250,000 of Federal Aid roads on the trunk system.

3. $225,000 will be offered as State Aid for construction of roads not necessarily on the trunk system.

4. Not more than $110,000 will be used for administration expense, all office and overhead expense, or approximately 3 per cent. of the yearly accomplishment.

5 $90,000, or 3 per cent. of the value of improvements effected, will be spent for surveys and plans and all preconstruction engineering.

6. $20,000 will be set aside for capital expenditures, repairs, additions and replacement to the physical plant.

How the Counties Will Be Affected

1. They will be relieved of an annual expenditure of $275,000 for trunk highway maintenance.

2. $600,000 of State money will be spent within their borders in co-operation with Federal funds and 20 per cent. county funds.

3. $225,000 will be made available for them annually for important highway construction of a standard not necessarily as high as Federal Aid construction and not necessarily on the trunk system.

4. They will be saved $275,000 in maintenance, will secure $225,000 of State Aid and $600,000 of State money matched with their own funds against Federal Aid, a total $830,000 in excess of what they now get from motor vehicle fees.

How the Counties Will Be Affected

1. The policy will enable the matching of all Federal Aid apportioned to the State and not now matched, amounting to $6,500,000 and will prevent the loss of approximately $1,000,000 of this amount of Federal money next July 1.

Nevada Gasoline Tax Law

As we have already noted several times, a large and constantly increasing number of states are obtaining revenue by the taxing of gasoline used by motor vehicles, most of the revenue thus derived being used for highways, although at least one state, South Carolina, turns half of the revenue into the general treasury "to be used for defraying the ordinary expenses of the state government."

The different laws vary in the details of their application and operation. The following give the main points of the law approved on March 20th, 1923, by the state legislature of Nevada.

Motor vehicles are defined as including all vehicles, engines or machines, movable or immovable, which are operated or propelled by combustion of gasoline, distillate or other volatile and inflammable liquid fuels. Motor vehicle fuels are defined as including all fuel oils except kerosene oil. "Dealers" to which the law applies are defined as "any person, firm or corporation who imports or causes to be imported gasoline, distillate, benzine, naptha and such other volatile and inflammable liquids produced or compounded for operating or propelling motor vehicles as herein defined, for use, distribution or sale in, and after the same reaches the state of Nevada; and also any person, firm or corporation who produces, refines, manufactures or compounds such fuel in the state of Nevada for use, distribution or sale in this state."

Every such dealer must by the 15th of each month render a statement of all motor vehicle fuel sold or used by him during the preceding month and pay an excise tax of 2 cents per gallon thereon; this tax to be paid on or before the 15th of the month. Each dealer must keep a record in prescribed form of all purchases, receipts, use and sale of such fuel, these records including copies of all invoices or bills of sale and to be subject to inspection by the tax commission.

However, those using motor vehicle fuel "for the purpose of operating or propelling stationary gas engines, tractors, farm tractors, harvesting machines, aeroplanes or motorboats, or . . . for cleaning or dyeing or other commercial use of the same, except in a motor vehicle operated or intended to be operated upon any of the public highways of the state," will be reimbursed the amount of tax paid by him directly or indirectly upon presenting to the secretary an affidavit, accompanied by the original invoices, showing the purchase and stating the amount so purchased and used, the application being made within ninety days from the date of purchase.

From the excise taxes so received by the state treasurer, he shall pay annually the sum of $60,000 to the state highway fund and divide the balance among the counties of the state in proportion to the number of motor vehicles therein holding state licenses, which money shall be used by the counties as a road fund.

Violation of the act is considered a misdemeanor and is punishable by a fine of not exceeding $500 or imprisonment not to exceed six months, or both.

Gasoline Tax in Virginia

The chairman of the State Highway Commission of Virginia, H. G. Shirley, informs us that the Legislature has placed a three cent gas tax, two cents of which will go to state highways and one to feeder roads. It also passed a bill allowing the Governor to anticipate $1,700,000 under the mill tax appropriation, shown in his report as not being available until December.

Illinois Highways by Day Labor

In connection with its road program, the State of Illinois is operating four day-labor outfits on four separate sections of concrete paving work. C. M. Hathaway, engineer of construction of the Division of Highways, writes us that it is anticipated that these outfits will complete approximately 35 miles of the paving program during 1923. The Division has made active preparations in anticipation of car shortages, strikes, etc., by storing, between February 1st and May 1st, approximately 50% of the cement that will be required for this season as well as large amounts of coarse and fine aggregate.

Paving Prices in Centralia, Illinois

During the year 1922 six paving contracts were let by Centralia, Illinois, each being awarded to the lowest bidder, there being as many as ten bids to a letting. Payment was made in 6 per cent. special assessment bonds. Labor was obtained at 65c. an hour and teams at $1.00 an hour. There were no local materials and all had to be shipped in.

Asphaltic concrete with 2-inch wearing surface on a 6-inch base of 1:2½:5 concrete was let at 75c. per cubic yard for grading, $1.54 per square yard for concrete base, $1.56 for asphaltic concrete top, $1.02 per lineal foot for combined 12-inch curb and 24-inch gutter, $15 each for cast-iron inlets and $50 each for 4½-foot manholes.

Five contracts were awarded for Portland cement concrete pavements. These had a thickness of six inches at the sides and eight inches at the center and were made with a 1:2:3 mix using crushed limestone. The combined curb and gutter had a 6-inch curb and 12-inch gutter. Reinforcement was used in the pavement consisting of 35 lbs. of wire fabric per hundred square feet. The prices ranged from $2.42 to $2.60 per square yard for the concrete pavement, 10c. to 14c. per square yard for reinforcement, 85c. to $1.00 per lineal foot for curb and gutter, 65c. per cubic yard in all cases for grading, from 7c. to 9c. per lineal foot for ⅜-inch expansion joint, $11 to $15 each for castiron inlets and $40 to $50 for 4½-foot manholes.

Maintaining Earth Roads

An illustration of how figures may mislead is given in the report for the year 1921 of the Highway Commission of Utah, which has just been published. The Commission itself calls attention to this point in connection with its figures for maintenance of hard surface and of earth and gravel roads, respectively. The cost of maintenance of the former in 1921 averaged $154 per mile, while for earth and gravel roads it averaged only $86.20; but the latter cost was very low because of the fact that the roads were not adequately maintained. This is further emphasized by comparison with the cost of maintaining earth roads in Wisconsin during the same year, $187, and in South Carolina, where it was $252. On the other hand, the cost of maintaining the hard surface roads was unusually high, because a considerable mileage of them had been surfaced with Tarvia and the shoulders built up.

A Novelty in Highways

A highway has been patented by a Texas engineer, S. B. Moore, which is the most novel that has been brought to our notice for some time. The idea is that of building two lines of wheel ways of concrete, each wheel way being of sufficient width to allow for the varying gauges of vehicles; these concrete wheel ways occupying only perhaps one-quarter of the total width of the road and thus saving in cost. In order to provide for turning out or occasional divergence of the vehicle from the wheel ways, the spaces between and outside of these are filled with old road metal or asphalt macadam using gravel, and a wearing surface of asphalt macadam using broken stone is spread over the entire highway, thus giving a uniform wearing surface. In order to compel the vehicles to travel with their wheels directly above these concrete beams, a depression or wide rut is constructed in the surface over each beam, the sloping sides of which permit a vehicle to turn out but the depression being sufficient to make it much preferable to remain in the rut. Water falling on the road would naturally follow these ruts, and at low points in the grade the pavement is given a uniform cross slope toward one side or the other so as to lead the water into side ditches.

New Water Rates in Saint Paul

By James W. Routh, Consulting Engineer*

In preparing new rates to give necessary revenue increase, the system of uniform consumption charge and sliding scale of service charges was adopted.

After operating for ten years on the basis of rates established in 1912, the Saint Paul water department has found it necessary to revise its rate schedule.

In June, 1922, the Bureau of Municipal Research in a report prepared by the writer on the financial condition of the water department, pointed out the need for a revision of rates, and outlined certain principles which it was believed should govern the new rate basis. The revised schedule became operative January 1, 1923.

The new rates provide for a sliding scale of service charges, adjusted for meter size, with an even or level consumption charge of six cents per one hundred cubic feet of water. The old rates included no service charge, but imposed a minimum charge with the level rate of six cents per one hundred cubic feet. Tabulation of the former minimum charges and the new service charges is given below.

Meter Size	Former Minimum Rate Per Year	New Service Charge
⅝" & ½"	$ 3.60	$ 3.00
¾"	4.20	4.20
1"	6.00	7.20
1¼	7.20	10.20
1½"	13.20	13.20
2"	24.00	27.00
3"	54.00	60.00
4"	96.00	120.00
6"	216.00	240.00
8"	384.00	420.00
10"	600.00	600.00

The average domestic consumer uses about 400 cubic feet of water per month, at a present cost of 49 cents. Under the old rate schedule he paid 30 cents per month.

Statistics for the water department for 1912, when the old rate schedule was adopted, and for 1922, when the need for the new schedule became imperative, show graphically the reasons for the upward revision.

The amount of water provided in 1912 was 4,793,197 gallons; in 1922 this amount had increased to 7,548,000 gallons, or more than 50 per cent. The corresponding increase in revenue from the sale of water was only 30 per cent during that time.

During the war period, when many utilities found it necessary to increase their rates, the Saint Paul water department made no effort in that direction. But economy in operation cannot continue to offset increases in the cost of materials and supplies. And in addition, it has been necessary to augment the supply system and the distributing system with expensive improve-

*St. Paul Bureau of Municipal Research.

ments and additions. A new filtration plant, nearing completion at the present time, new reservoirs, and a prospective conduit or aqueduct connection between the present lake systems and the Mississippi River for additional supply, were cause for large bond issues. The sale of these bonds of course increased charges for interest and sinking fund, and there were corresponding decreases in revenue available for operation. The following table is significant in pointing out the increase in plant value, in operating costs, and in revenue during the ten year period prior to rate revision.

	1912	1922
Book Value of Plant	$5,655,954	$8,850,000
Sinking Fund	135,421	813,488
Gross Value	5,791,375	9,663,488
Outstanding Bonds	1,847,000	3,407,000
Net Investment	3,944,375	6,256,488
Net Increase in Value	.....	2,312,113
Revenue from Water Sales	370,700	441,550
Frontage Tax	64,495	76,901
Misc. Revenue	18,254	76,305
Total Revenue	453,449	594,756
Operating Expense	118,136	345,000(est.)
Interest and Sinking Fund	117,895	250,000(est.)

About 70 per cent of the supply is metered, and the department is making every effort to make the percentage 100. As an aid to this, the flat rates for unmetered water were materially increased by the recent rate revision, by the imposition of a uniform service charge of 25 cents per month on the existing rates.

Sewerage in England

With the construction about fifteen years ago of the sewerage system of Baltimore, the existence in America of large cities without sewers ceased. Although the construction of sewers was begun in England earlier than in this country, there are still cities in that country which have not adopted modern sewerage. The city of Hull, with a population of about 300,000 has only recently decided to construct a sewerage system at a cost of about a half million dollars. At the present time Hull is using the pail midden system and a recent inquiry showed that 8,342 houses in the city had no outlet at the rear and the night soil had to be carried through the houses. As might be expected, the medical health officer stated that the death rate from typhoid was larger than the average in large municipalities.

Fairmount Dam, Philadelphia

For many years an old timber dam has been used as part of the plant of the Water Works of Philadelphia and for a number of years the engineers have been calling attention to its dilapidated condition and the danger that it might go out at any freshet. Plans have at last been authorized for replacing this with a modern concrete structure which is estimated to cost $700,000.

The new dam will be about 1,510 feet long. The height is not great, about 800 feet of the length being from 12 to 15 feet deep, where the rock is exposed in the stream bed. At the eastern shore, adjacent to the aquarium, bedrock lies from 25 to 30 feet below water-level, and the dam will be carried down to this. Borings have been made to determine the depth and character of the rock at the site of the dam. The dam will be constructed of concrete with as large as possible a proportion of plums. The design has been made conservative with a very large factor of safety.

In constructing the dam, the present timber dam will be used as the upstream side of a cofferdam, while the downstream side and end of the cofferdam will be built of interlocking sheet piling.

It is expected that the coming summer will see the work of constructing the dam actively under way and that it will be completed within two years, and within less time if there is not an unusual number and intensity of floods in the river.

Erecting Tanks Downward

In constructing steel tanks for oil in Belgium, the practice is to build them from the top down instead of from the bottom up, according to "The Water Tower." While this refers to oil tanks, we presume that the same method would be used for water tanks, although these are usually made with heavier plates. The method may be described as follows:

The bottom of the tank is first assembled and riveted on the foundation. The top ring is then assembled on blocks about 8 inches high and riveted together. Large ratchet jacks with extra heavy footpieces are then placed on the bottom plate under this ring, a jack being placed under each plate, and all jacks are raised at the same speed until the plate is high enough to permit the second ring to be added. Where there are sixteen plates in a ring, two are bolted in place in each quarter of the tank and blocks placed under each one, following which the jacks are removed and the other half of the plates are put in place and blocked and the second ring riveted. This operation is repeated until the entire shell has been riveted in place, the bottom ring being bolted to the angle of the bottom plate instead of being raised on blocks.

Where the tank is not over 30 feet in diameter the roof is supported by a truss consisting of a center column 6 or 8 feet long from the bottom of which rods with turnbuckles run to the top of the top ring, thus forming trusses. Where the tank is over 30 feet in diameter, the center column is made in sections with lengths the same as the width of the sheets and is jacked up in the same way that the side plates are.

High-Class Country Roads

Union County, New Jersey, because of the large amount of traffic it must carry from neighboring great centers of population, finds it necessary to construct the highest class of roads. County Engineer Jacob L. Bauer reported that at the end of 1922 the county had 69 miles of improved highways, of which 33 were paved with sheet asphalt and asphaltic concrete, 22 miles with cement concrete, 10 miles with macadam and telford macadam, 1 mile with brick, nearly

a mile of asphalt block and a small stretch of granite block. A number of the roads constructed or contracted for last year are of three-inch sheet asphalt on a 6-inch concrete base, which is considered the highest type of construction. One stretch of such pavement, a trifle over a half-mile long and 40 feet wide, cost $45,524. This was in the city of Elizabeth and the county paid for only the central 22 feet, $20,740. The total expenditure for the county roads for the year was $348,450.

Hydraulic Dam Construction with Electric Dredge

A dam is being constructed by hydraulic fill by the Puget Sound Bridge and Dredging Company to provide a storage reservoir of the Wichita County Water Improvement District No. 1. The dam is located on Big Wichita river about 50 miles from Wichita Falls, Texas, and 8 miles from the nearest railroad station.

The dam is approximately 100 feet high at the deepest point, has side slopes varying from 3:1 to 2:1, is about 3,000 feet long and will contain more than 1,300,000 cubic yards. To carry the river during construction and serve as a permanent feature, there were constructed six concrete conduits, each 7 feet in diameter, at the lowest point in the river bed. These are equipped with gates and it has been computed that they will carry any flood likely to occur during the construction.

The river bed is underlaid with blue clay and shale. A row of steel sheet piles was used as a cut-off across the river channel and the first bench. From there to the end of the fill a ditch was excavated by dragline and steam shovel down to impervious material to receive the core wall.

The embankment is being built of material taken from the river immediately above the dam site and is composed of gravel, sand, clay and silt, with sand predominating. The material is excavated by means of a ladder dredge and pumped to the dam, where it is deposited in the ordinary method of hydraulic dam construction, the fine silt and disintegrated clay being washed into a center pool in the middle of the dam to form the core wall. Wooden bulkheads are used on the slopes of the dam to retain the material as it is deposited from the discharge pipe—a system that was successfully used in filling streets on the waterfront of Seattle. The waste water is returned to the pool above the dam. Care is taken to keep the center pool narrow enough and its bottom high enough not to endanger the stability of the coarser material forming the remainder of the dam because of hydrostatic pressure from within.

The water of Wichita river contains a large amount of mineral salts which are bad for boilers. This made steam power objectionable for the dredge. As fuel oil is abundant and cheap, this might have been used. However, the district had decided to build a high-tension power transmission line from Wichita Falls to the dam site, and the contractors had available the main elements essential for an electric dredge of the size and capacity desired, and therefore an electric dredge was decided upon.

The dredge was designed especially for this work by the contractors, the designing requiring sixty days. The keel was laid March 21st and the machinery installation completed and dredge ready in July, although actual operation did not begin until September, 1922. The dredge has a hull of wood 42 feet by 11 feet, which was launched into a pit dug by a dragline excavator in the bank of the river, deep enough to float the dredge even should the river go dry. The spuds are of wood 26 inches square and 76 feet long. All other parts of the dredge are of metal. The ladder is 75 feet long, carrying an 8-inch cutter shaft. The discharge pipe is 20 inches in diameter. The total power on the dredge was 2,100-h.p., this high power being provided to raise the excavated material to a high lift.

Groined Arches

Principle features of designs that long practice has demonstrated to be safe, including form and span of arch, size of columns and mix of concrete.

By far the largest number of covered reservoirs, filters, etc., that have been built in this country have had their roofs constructed of concrete as groined arches, only a very few having used reinforced concrete slabs for this purpose. The designing of such arches was the subject of a paper before the American Society of Civil Engineers by Philip O. Macqueen of Bay City, Michigan.

Mr. Macqueen states that designs of groined arches are entirely empirical, the exact designing from a strictly mathematical or even logical viewpoint being impossible. However, the groined arch has been used for more than two thousand years and, when carefully constructed, its safety is beyond question.

In order to obtain data on which to base a design which will embody what has been proved to be safe practice, the author has analyzed the designs of thirty different groined arches used for reservoir roofs in this country, ranging in date of construction from those at Albany, N. Y., built in 1899, to roofs built in Cleveland in 1916 and others designed in 1920 for the same city but not yet completed. These roofs varied in the clear span between columns from a minimum of 10 feet to a maximum of 19.16; in rise of intrados of from 1.5 feet to 5.0 and rise of extrados from 0.5 to 2.58 feet. In every case the thickness of the arch at the crown is 6 inches.

Mr. Macqueen states that while some groined arch roofs have failed, in each case the failure has been due to faulty foundations, poor concrete, or unusual stresses during construction, but no cases are on record of their having failed on account of poor design or excess loading.

Discussing the form of the arch, the author considers that the elliptical shape of intrados lends itself to a systematic arrangement at the

Data on Concrete Groined Arches for Reservoir Roofs

No. (1)	Date. (2)	Location. (3)	Clear span ($2a$), in feet. (4)	Rise of intrados (b), in feet. (5)	Crown thickness (t), in feet. (6)	Rise of extrados (h), in feet. (7)	Span, center to center, of columns ($2c$), in feet. (8)	Ratios: $\left(\frac{b}{2a}\right)$ (9)	Ratios: $\left(\frac{h}{b+t}\right)$ (10)	Average thickness of roof, in feet. (11)
1	1903	Watertown, N. Y.....	10.000	1.500	0.500	0.833	11.500	0.150	0.417	0.562
2	1909	Providence, R. I.....	10.250	2.500	0.500	1.250	11.917	0.244	0.417	0.635
3	1903	Ithaca, N. Y.....	10.500	1.500	0.500	0.833	12.000	0.143	0.417	0.568
4	1909	Springfield, Mass.....	11.333	2.000	0.500	1.250	13.000	0.177	0.500	0.566
5	1911	Toronto, Ont., Canada.....	11.333	2.000	0.500	1.167	13.000	0.177	0.467	0.582
6	1910	Owen Sound, Ont., Canada	11.500	2.500	0.500	1.167	13.000	0.218	0.388	0.625
7	1903	Washington, D. C.....	11.833	2.500	0.500	1.417	13.667	0.211	0.472	0.606
8	1899	Albany, N. Y.....	11.917	2.500	0.500	0.500	13.667	0.210	0.167	0.774
9	1900	Superior, Wis.	12.000	2.500	0.500	0.500	13.667	0.208	0.167	0.747
10	1903	Washington, D. C.....	12.167	2.500	0.500	1.417	14.000	0.206	0.472	0.600
11	1912	Roland Park, Md.....	13.000	2.667	0.500	1.500	14.667	0.205	0.473	0.593
12	1907	Philadelphia, Pa.	13.167	3.000	0.500	1.750	15.000	0.228	0.500	0.609
13	1907	Lawrence, Mass.	13.167	2.750	0.500	1.667	15.000	0.209	0.513	0.590
14	1908	Pittsburgh, Pa.	13.167	3.000	0.500	1.750	15.000	0.228	0.500	0.609
15	1904	Philadelphia, Pa.	13.417	3.000	0.500	1.750	15.250	0.224	0.500	0.607
16	1913	Baltimore, Md.	13.500	3.000	0.500	1.750	15.000	0.222	0.500	0.582
17	1912	Grand Rapids, Mich.....	13.833	3.000	0.500	1.833	15.000	0.217	0.524	0.543
18	1907	Philadelphia, Pa.	14.000	3.000	0.500	1.750	15.833	0.214	0.500	0.604
19	1902	Milford, Mass.	14.000	3.000	0.500	1.500	16.000	0.214	0.428	0.658
20	1909	Springfield, Mass.	14.000	2.750	0.500	1.500	16.000	0.196	0.462	0.623
21	1916	Cleveland, Ohio.....	14.080	3.500	0.500	2.000	15.750	0.249	0.500	0.618
22	1908	Columbus, Ohio.....	15.167	3.167	0.500	1.917	16.833	0.209	0.522	0.568
23	1905	Washington, D. C	15.500	3.500	0.500	2.083	18.000	0.226	0.522	0.646
24	1908	Pittsburg, Pa.	15.750	4.000	0.500	2.167	18.000	0.254	0.482	0.683
25	1912	New York City.....	16.000	3.750	0.500	2.000	18.000	0.234	0.470	0.653
26	1913	Minneapolis, Minn.	16.333	3.500	0.500	2.000	18.000	0.214	0.500	0.600
27	1913	Montreal, Que., Canada....	17.000	4.250	0.500	2.000	19.000	0.250	0.422	0.700
28	1912	New York City*.....	18.000	4.500	0.500	2.500	20.000	0.250	0.500	0.646
29	1912	New York City*.....	19.160	5.000	0.500	2.580	22.000	0.261	0.469	0.744
30	1920	Cleveland, Ohio*	17.960	4.500	0.500	2.500	20.292	0.253	0.500	0.675

*Under construction or proposed.

column supports, while the flattened form of the arch permits long spans with a minimum loss of headroom; and that the parabolic extrados gives a uniformly increasing thickness to the arch; and it is difficult to conceive that more effective curves could be used for the purpose.

As to span, he considers that 10 feet is too short to be economical, but that about 15 feet center to center of columns is considered good practice where the columns are less than 20 feet high, while for columns between 20 and 30 feet in height the span is usually 18 to 20 feet, the latter being probably the maximum that can be recommended for groined arch work.

In the matter of rise of intrados, he finds that the average in the case of the thirty roofs listed is represented by one-third the clear span of the arch minus 1.5, although the several arches vary from 80% of this to 111%. The practice as to rise of extrados he finds to be represented by one-half the sum of the rise of the intrados and the crown thickness.

As to the concrete mix used, the difference between a mixture of 1:2½:5 or 1:3:5 as compared with 1:2:4 would be 2% of the total cost with concrete at $15 per cubic yard, and he recommends the use of the richer mixture.

The normal loading for the roof, he states, is usually taken as two feet of earth plus a live load of 100 pounds per square foot. He thinks that the flat slab roof may be more economical for small, shallow reservoirs of an area of less than one acre on account of the lower cost of form work, but for deeper reservoirs covering an area of several acres the groined arch roof will prove much more economical.

Street Openings in Plainfield, New Jersey

In Plainfield, New Jersey, a separate permit must be obtained from the city engineer for each street opening and a deposit made of $10 for an opening of not more than 50 feet in length and $2.50 for each additional 50 feet; and, in addition to this, further deposits depending upon the kind of pavement, $7 per square yard being required for stone block, brick, asphalt or other material on a concrete foundation; $6 for cement concrete pavements; $4 for bituminous concrete or bituminous macadam on Telford base, or stone block on sand foundation, and $3 for macadam. The trench is backfilled by the applicant, but the pavements are replaced by the city and the cost deducted from the deposit and the balance returned six months after the date of the permit if the trench and the street surface are then in good condition.

The backfilling must be done in layers not more than 6 inches deep, thoroughly rammed, and also flushed with water if necessary. Any tunnelling

under a pavement having a concrete base must be backfilled with a concrete composed of one part Portland cement and nine parts of steam boiler cinders or other approved material completely filling the cavity. Where the pavement has a concrete base it is cut back 9 inches wider than the trench on each side and the edge of the old concrete bevelled so as to be 4 inches wider at the top than at the bottom; and the new concrete is made 2 inches thicker than the original and is reinforced with No. 10 expanded metal or equivalent wire fabric.

Curing a "Sick" Sewer System

An example of "Paralysis" of purpose due to lack of use and neglect of the sewers of Independence, Missouri.

By Leon B. Reynolds*

Independence is a city of about twelve thousand population, situated about nine miles east of Kansas City, Missouri. The topography of the city is rather rough, with an extreme range of over 150 feet in elevation. The business section occupies the highest ground and the drainage flows in five different directions. These draws fall rapidly and, of course, do not carry much water except during wet weather, and are often entirely dry.

The original sewer system was designed about 1899 and four outlets were provided with sewage disposal plants. The backbone of the system has remained unchanged and lateral extensions have been added as the city has grown. The original sewage disposal plant for each outlet consisted of a shallow septic tank and a contact bed, one of the earliest installations of this type in the country. The septic tanks were circular radial-flow tanks 5 to 8 feet deep; the contact beds were originally filled with alternate layers of brick and coke breeze. By the year 1908 the coke breeze had broken down and the beds had become clogged; at that time the filling material was removed and the beds were filled with layers of sand, stone, gravel, and brick. At the west plant a dosing tank and sprinkling filter were later constructed in order to purify the sewage more thoroughly. The contact beds were later abandoned entirely, the septic tanks ceased to function, due to their filling up with solids, and the sprinkling filter became clogged, due to excess of solid matter being carried over from the septic tank.

Early in 1921 the city engaged the firm of which the writer is a member to examine the sewer system and plants for treatment of sewage and to recommend the necessary improvements. A sanitary survey of the city was made to determine the number of houses connected to the present sewers. The authorities were startled to find that 1,500 houses, or more than half the total number in the city, were not connected to sewers; of these 1,500 houses not connected, 700 fronted on streets where sewers were already laid and sewer service was available, and 800 were in localities where no sewers had been laid. The amazing discovery that nearly one-quarter of the population occupied residences unconnected with the sewers started an agitation to compel the use of sewers where available.

Practically all of the existing lateral sewers were found to be provided with flush-tanks, 101 being the total number. Of this total only 32 were found to be operating, 41 were receiving no water due to the inlet being stopped up or turned off, and 28 were not flushing due to leakage through the siphon or the walls of the tank. In addition to the waste by

*Member of firm of Burns & McDonnell Engineering Co.

SOUTH TREATMENT PLANT DURING CONSTRUCTION.

leakage in the 28 which were not flushing, the water used by the 32 operating tanks would have been sufficient to allow each of the 101 tanks to discharge once every 16 hours. This condition was also rather startling to the city, and may be common to other cities.

Due to the small amount or lack of flow during the summer in the draws used as final outlets, the conditions below the sewage plants were very offensive. The north, east and south plants consisting of septic tanks and contact beds were practically not functioning at all and were entirely neglected, while the west plant consisting of septic tank and sprinkling filter was neglected and its efficiency was low. Damage suits had been threatened and one suit had already been filed by land owners below the outlets and the city was facing considerable litigation. If the Missouri State Board of Health had actively and efficiently regulated the disposal of sewage from cities of that state the existing conditions would have been remedied long before.

The most startling discovery of all was that the effluent from the inefficient west plant discharged into a draw about a mile and one-half above Fairmount Lake, located in one of Kansas City's amusement parks, on whose shore is the best natural bathing beach in the city. Physicians stated that they had treated numerous infections among bathers but the cause seemed to be unknown, and the public generally was not aware that the sewage from the west district, in which the city hospital was located, found its way into this lake. As soon as the real condition became public the owners of the amusement park threatened suit for damages unless the city installed a sterilization plant, and the city promptly installed a temporary plant of this kind to treat the effluent with liquid chlorine. In addition the owners of the amusement park treated the lake with liquid chlorine applied from a plant installed in a row-boat. The effect of these precautions was quickly noticed in the reduced bacterial content of the lake water.

A bond issue was put up to the people on the basis of the preliminary report by the engineers recommending new treatment plants consisting of Imhoff tanks, sludge beds, dosing tanks and sprinkling filters for the north, east and south districts and ejector pumping plants for the west, southwest, and southeast districts. The engineers conducted an educational campaign for the bonds and they were voted in June, 1921, by a vote of 7 to 1. Contracts were awarded in September, 1921, to Ray and Son of Baxter Springs, Kansas, for the construction work, and to Simplex Ejector Company of Chicago for the ejector equipment. The construction work was completed in August, 1922, and the plants have all been in operation since that time.

The south plant is designed for a flow of 500,000 gallons per day, the north plant for 200,000 gallons per day, and the east plant for 100,000 gallons per day. The settling chambers of the Imhoff tanks are designed for a two-hour retention period on the basis of the entire daily flow occurring during eighteen hours, with provision for reversal of flow.

The velocity of flow through the settling chambers varies from .003 to .008 feet per second; the total depth below sewage level ranges from 19 ft. 8 in. to 23 ft. 6 in. The ratio between gas vent surface and sludge room surface is approximately 1:4. Sufficient capacity is provided in the sludge compartment up to eighteen inches below the slot for storage of 150 days' sludge.

Sludge is withdrawn under hydrostatic head of 5 ft. 6 in to 6 ft. upon sludge beds having areas of 280 to 360 sq. ft. per thousand population. The sludge beds have a surface sand layer six inches thick and underdrains are four-inch drain tile.

The dosing tanks are of the ordinary tapered type. The sprinkling filters are designed to operate at the rate of 2,500,000 gallons per acre per day. The best local limestone in sizes from ¾-inches to 2½-inches was used for filling material with a depth varying from 5 ft. to 5 ft. 6 in. Distributors are of vitrified pipe encased in concrete; Merritt square-spray nozzles are used and underdrains are six-inch split drain tile. The total head through the plants from the sew-

SPRINKLING FILTER AT SOUTH TREATMENT PLANT, INDEPENDENCE, MO.

age level in the Imhoff tanks to the invert of the main drain from the filters is 14.6 feet at the north plant, 14.4 feet at the east plant and 17.8 feet at the south plant.

Ejector sewage pumping stations were constructed to pump the sewage from the west, southwest, and southeast districts into sewers draining by gravity into the south treatment plant. The west district is relatively small and its sewage, including that from the city hospital, is now prevented from being discharged into the bathing lake. The southwest and southeast districts are too low to drain by gravity into existing sewers.

At each ejector station there are two Simplex ejectors of 75 gallons capacity, two motor-driven Gardner vertical compressors with short belt and idler drive and Westinghouse automatic pressure regulator control. The discharge lines are six-inch cast iron pipes. At the west station the static head is 60 feet, at the southwest 24 feet and at the southeast 56 feet. A moderate speed of 250 r.p.m. was specified for the compressors in order to secure maximum service and reliability with a minimum of maintenance and attendance. Some difficulty was encountered with the unloader equipment due to unreliability of the local power, and bleeder tanks were installed on the discharge lines from the compressors to relieve the pressure and allow the compressor to start against a smaller pressure after any interruption of power of more than fifteen seconds.

The total cost of the three sewage treatment plants was $87,950, including land, and the cost of the ejector equipment was $11,735. The plants are under the supervision of the sewer superintendent, E. M. Riddle, who was formerly city engineer, and who is giving the plants the attention which they deserve. Some difficulty has been experienced thus far with the Imhoff tanks due to foaming, but the sludge is being kept down by raking and spraying with water, and conditions are improving. A removal of from 70 to 75 per cent. of the settleable solids is being secured and a good quality of sludge is being produced. The relative stability of the final effluent is showing a gradual improvement as the bacterial action in the filter beds becomes better established.

Philadelphia Sewer Specifications

For many years the Bureau of Surveys of Philadelphia has built sewers under specifications providing for a lump sum rather than unit price bids. Recently the Contractors' Association of Philadelphia has been co-operating with the chief engineer of the Bureau of Surveys in changing this plan to one more in conformity with modern methods.

In presenting the matter to the Bureau of Surveys, the secretary of the Contractors' Association urged that contractors be permitted to bid on inlets, manholes, house connections, curbing, etc., as items separate from the cost of the sewer itself; also make unit bids for excavation for different types of sewers, with additional prices for spurs and other appurtenances. It was also requested that a surety company guarantee be required for each proposal instead of a general bond for a contractor under which he could bid on fifty sewers if he desired. Another request was that contractors be furnished with plans and specifications that they can study in their own offices, rather than requiring them to inspect them in the office of the bureau, where frequently two or three are endeavoring to obtain the desired information from a single plan at the same time.

Replying to these suggestions, under date of March 14, J. A. Vogleson, chief engineer and surveyor, announced that at the next letting trial would be made of three of the changes desired, proposals being asked on items given in the summary of the work, a guarantee bond required for each bid for sewers when the bid exceeds $5,000, and blueprints being purchaseable by contractors from an authorized blueprinter.

The contractors also suggested that core borings be made for determining the nature of the ground and that the bureau investigate the qualifications of bidders before awarding contracts, but apparently these suggestions were not adopted by the bureau, nor was the desire of the contractors that bids be received for excavation of different types of sewers. It is possible, however, that the bureau is taking further time to consider these requests before making final decision.

Feeding a Six-Bag Paver

In constructing an 11-mile section of 18-foot concrete pavement on the Pacific Highway near Canyonville, Oregon, the contractor, S. A. Moceri of Tacoma, found himself encountered with the necessity of hauling his aggregate and cement by truck for 17 miles over a road containing four miles of a continuous 5½% grade and two miles of a 2% grade. This long haul made the delivery of materials on schedule uncertain and, to prevent delays, they were hauled in advance and stored on the grade a long way ahead of the mixer.

The mixer used was a six-sack Koehring paver and feeding it by wheelbarrows was out of the question. The plan adopted by the contractor was that of using three-wheel trucks, each carrying a single hand-dump batch box, which were shuttled back and forth between the mixer and the stock piles.

The pebbles used as coarse aggregate were loaded into elevated hoppers by means of a Mogul loader made by the Spears Wells Machinery Company, which consisted of a portable bucket elevator mounted on continuous treads and fed by a toothed ribbon conveyor. In obtaining a load, a truck stopped under the elevated hopper and received from it by gravity pebbles filling the batch box up to a predetermined point; the truck then proceeded to the nearest sand pile where the sand was shovelled in by four men, sand being more easily handled by hand than pebbles. The truck then proceeded to the mixer and dumped the load into the skip, where cement was added. The trucks did not turn around but backed from the mixer to the elevated hoppers.

Private Fire Protection Charges and Metering of Sprinkler System

Principles underlying the equity and law of charging for private service and decisions of various Public Service Commissions. Requiring meters on private fire services.

By John Simpson

The question of the authorization by a public service commission of a charge for private fire services connected with automatic sprinkler systems of industrial establishments is by no means a new one and has been considered by some of the courts and by most of the commissions of the various states. It has been generally held that a reasonable charge should be imposed for private fire service and in the great majority of cities and towns such charges are authorized.

Private fire protection is usually required either by special municipal ordinance or by requirements of fire underwriters, who make differential rates dependent upon the various risks of the insured. Private fire protection lowers the risk; and to secure the lesser risk and lower insurance rates, underwriters desire the largest practicable size of service connection, consumers desire the lowest possible rates (both insurance and water), and the water utilities in general desire to secure the greatest possible revenue from the service. Before the period of regulation of rates, this resulted in a three-cornered controversy, ending in each particular case in a trade and a special contract. Lincoln v. Lincoln Water & Light Co., 4 Ill. P. U. C. R. 113 (1916).

The owner of a two-story garage equipped with a sprinkling system complained to the Pennsylvania Public Service Commission of the water company's metered and ready to serve charges therefor, contending that the rate for private fire protection service, with adequate pipe connection, should not exceed the company's fire hydrant rate. The company claimed that it was not selling private fire protection, but, with the exception of the fire hydrant rate, sold water only through metered connections at rates alike to all consumers for all purposes. The principal question involved in the case was whether or not a water company should have a special and definite rate for private fire protection service, especially that required in the use of sprinkling or other automatic devices in the interior of buildings. The Commission sustained the complaint, Wood v. Springfield Consolidated Water Co., July 26, 1921, and directed the water company to submit to the Commission for its approval a special or definite rate covering private fire protection service rendered by the installation of sprinklers or other automatic devices.

In the course of its opinion the Commission pointed out that there is very wide divergence in the practice of water utilities throughout the country in dealing with private fire protection services. Some utilities make no rates applicable to interior automatic devices other than those which apply to the supply of water for domestic consumption; others have rates comparable in varying degrees to public fire protection rates; while in still other instances municipal utilities have sought to encourage the use of private fire protection services by making no charge therefor.

It is quite apparent that for water utilities adequately to supply private fire protection services, in addition to that which is required in the public service, they should have a fair measure of return. There is, no doubt, great difficulty in satisfactorily segregating charges of this kind. But it would appear to be a fair principle, where a consumer has, for example, installed throughout a two-story garage building a sprinkling system designed to be connected with the utility's water main, to have a charge for private fire protection service that would represent a middle ground between the yearly rate for a fire hydrant, and the readiness-to-serve domestic consumption rate. A special rate based on such a principle would more equitably divide benefits between the public, the utility, and the user of private fire protection service, than the one based upon either extreme of charge.

Some water utilities have made the following provision for private fire protection service:

1. Installation of separate service lines, with detector meters to prevent waste or theft of water.

2. Special readiness-to-serve charges based upon size of meter connection, considerably reduced from the charges imposed for domestic consumption purposes, due to infrequent consumption of water.

3. The usual rates for water actually consumed.

The Pennsylvania Commission considers that the utilities which have adopted such rate principles have justly and equitably met the situation. They have protected themselves against water losses; have provided themselves with fair return for steadily service and actual water consumption, and have not restricted the benefits which both private consumers and the public have obtained from the installation of special

fire protection devices in factories, stores, theatres, hotels and other buildings of general business nature.

The Pennsylvania Commission considers that, while it is true that the installation of automatic fire protection devices is of primary benefit to the properties immediately concerned, there is no doubt that such private fire protection services afford a considerable degree of public benefit in limiting the extent of destructive fires. This is attested by lower insurance rates, and the laws of Pennsylvania themselves take cognizance of the fact that private fire protection devices may considerably reduce hazard to life and property. It therefore follows that they are valuable supplements to the ordinary means of public fire protection.

In 1901 it was held, Loveman v. City Water Co., 7 Tenn. Ch. App. 596, that a water company which supplies the pressure and water for an automatic sprinkler for a private corporation and stands ready to supply the necessary water in case of fire through a four-inch pipe performs a service in thus standing ready which is not included in its contract with the city to supply water for fire protection, and has the right to make a reasonable charge against the corporation. There was no attempt to charge for the water that was in the consumer's tank and in the pipes of its automatic system; that had already been paid for, having gone through the meter.

In the case of the application of the water department of the city of Evansville to the Indiana Public Service Commission (August 5, 1922) for authority to establish a charge for automatic fire sprinkler service, the Evansville Chamber of Commerce opposed the grant on the grounds that the installation of such a system redounds to the advantage of the water utility and of the community generally because its operation tends to extinguish fires at their inception and thus obviates the necessity of pumping large quantities of water, and that very little, if any, additional expense, is incurred by the utility in having its mains connected with such automatic sprinkler systems.

The evidence before the Commission, as stated in their opinion, showed that an expense does fall upon the utility in regard to furnishing connections for private fire protection systems, not even taking into consideration the fact that the utility must stand ready to furnish the amount of water which would be required by such systems in case of fire and must have the plant and distribution facilities necessary for this purpose. A good many of these systems have large tanks used in connection with them and these tanks require refilling and replenishing on account of losses of water by leakage and evaporation. The systems, too, are often drained and in such cases replenishment is necessary. A system of inspection must be maintained by the water works department in order to avoid waste of water through leaks or taps in sprinkler systems, and occasionally a loss of water occurs through sprinkler leakage. The evidence showed that there were 76 automatic fire sprinkler systems attached to the department's mains and that in all cases these connections were separate from the service through which the establishments maintaining them were served for their regular commercial needs.

The Commission authorized the department to make a reasonable annual charge for connection with private fire connection systems.

In North Coast Power Co. v. Pittock & Leadbetter Lumber Co., (1922) 118 Wash. 543, 204 Pac. 180, the sole question was whether the water company had the legal right to charge for fire protection service to a sawmill in addition to that charged through the meter for ordinary use of the mill. There was no question of the reasonableness of the rate charged. The system used here was a stand-pipe with hose connections. The pipe leading to and from the meter was a 6-inch pipe. The meter was a 3-inch one, around which was a by-pass which, in the event of fire, would permit the water to flow through the 6-inch pipe without passing through the 3-inch meter. To be able to furnish fire protection service it was necessary for the water company to have larger mains, higher pressure and greater reserve capacity than would be required for ordinary domestic use.

The court quoted and adopted the reasoning in Gordon & Ferguson v. Doran, 100 Minn. 343, 111 N. W. 272, where it was held that, in addition to the meter rate for ordinary use, an additional rate could be charged for the service rendered for fire protection. In that case the consumer maintained an automatic sprinkling system, connecting with the water mains of the city. It was there said:

"So long as water supplied for protection against fire is a purely public service, under the control and management of municipal authorities generally and under the fire department specifically, no direct charge to individuals is proper. When, however, a sprinkling connection is made with private premises, the situation is substantially different. These promises and the primary causes of catastrophe to the building and of the consequent possible use of disastrous quantities of water are primarily under the control, not of the public, but of the owner. A peculiar personal service is provided for his benefit, which is not enjoyed in common by the community in general, but is available only to a limited class of individuals. It does not advance the reasoning in this connection to split hairs between the 'use' and the 'consumption' of water. As a matter of good sense the property owner beneficially employs the water mains for his own purposes and to his own advantage, although he may not, except in case of fire, actually draw any water from the pipes. It is necessary and proper that for this he should pay. In effect he gets something of pecuniary value from another, which that other is not compelled to give except on the basis of contract."

The Minnesota case was also quoted with approval and the principle therein was applied by the Maine Public Utilities Commission in 1916.

when it held that a schedule of rates of the Portland Water District giving free private fire protection service to consumers of a minimum amount of water at the ordinary rate was unjustly discriminatory; that the district had no right to furnish this service free, and that the fact that private sprinklers are a community benefit, reducing the amount of water which would otherwise be used through the municipal fire apparatus, is a matter rather for the municipal authorities than for the water district. This finding was adhered to on a later hearing in 1917, where the question of private fire protection charges was thoroughly investigated, and charges fixed, consideration being given to the fact that the amount of water used by private fire installations might be much less than that used by the public fire protection system.

REQUIRING METERS

It is unreasonable to require a water company to stand ready to extinguish fires without some certain and sure compensation. The fire protection system is installed with the earnest hope that no water will be used. In the ordinary service the installation is wholly for consumption of water.

For this reason the Indiana Public Service Commission, Commercial Club. v. Terre Haute Waterworks Co., P. U. R. 1916 B. 180, was of opinion that all fire protection service should be metered, that the minimum charge should be 50 per cent. greater than for other services, and that such fire protection system patrons should pay for all water used at the usual rates.

The Wisconsin Commission, Manufacturers' Assoc. v. Kenosha, January 6, 1919, held that an order of the board of water commissioners of a city requiring the installation of meters in connection with automatic sprinkler systems in compliance with an order of the Commission, was reasonable, the general experience of waterworks operators showing that "in any city where there exists a considerable number of unmetered connections between city water mains and private fire-protection pipe systems, there is likely to be some misuse and abuse of the service, and large quantities of city water used surreptitiously for general factory or industrial purposes, or wasted from neglected leaks or from both causes." The Commission regarded a meter as preferable to reliance on periodical inspection. "A meter is a mechanical inspector which is on duty day and night throughout the year, and one which not only detects the existence of a flow of water, but measures the amount. It is far more reliable and satisfactory, at least from the standpoint of the waterworks operator, and apparently less expensive." The Commission did not consider well-founded objections by property owners and insurance companies that the meters might become clogged and shut off the service altogether. This ruling was approved by the Pennsylvania Commission, Riverton Consolidated Water Co. Case, September 9, 1919.

The Wisconsin Commission in 1915 found the consensus of opinion among operators to be that a minimum charge for private fire protection is reasonable, based on the idea of the "readiness to serve" principle, varying with the size of the connection.

In the case of the Beloit Water, Gas & Electric Company the Commission considered that the water utility would be justified in metering all services installed for the purpose of such protection, not with the idea of charging for water used in case of fire, but for protection against surreptitions use, as close inspection and supervision had been found in many cases to be inadequate. The Commission found it difficult to establish a definite amount chargeable against private fire protection service, but assessed the charge according to the size of the service openings.

AMOUNT OF CHARGE

The Illinois Public Utilities Commission, in Lincoln v. Lincoln Water & Light Co., 4 Ill. P. U. C. R. 113, (1916) where consumers installed and owned their individual fire protection apparatus, made a service charge proportional to the size of the service pipe; where the consumer desired the company to install fire lines for him, it suggested that a combination of the service and footage rates might have to be adopted.

The Illinois Commission found it unexpedient to apply the rule adopted in the Lincoln Rate Case in the Pekin Waterworks Case (1917) because of the divers uses made of private fire protection in the city of Pekin, and resorted to a usage charge superimposed upon a service charge based primarily on the diameter of the service pipe. Many theoretical elements of the cost of this service were considered in fixing the rates, such as, size of service, use of service in event of a fire, relative protection of small and large plants, aid of municipal hydrants, and other services. And in establishing a private fire protection rate for the Northern Illinois Water Co. (1917) the same Commission took into consideration the size of the consumer's connection with the utility's distribution main, the number of outlets or sprinkler heads on the consumer's sprinkling line, and the number of private fire hydrants installed on the consumer's premises.

In the case of the city of Charleston and town of South Charleston where there were about seventeen consumers having a sprinkler system installed in their respective places of business for private fire protection, and three industrial consumers each with two hydrants for the same purpose, the evidence before the Commission did not show the amount of water used by these private systems, nor the burden they imposed upon the water company, so that it was difficult to estimate the amount of revenue this class of consumers should contribute. The West Virginia Public Service Commission, however, considered that as the property of these consumers was situated within the municipal limits. and therefore burdened with its proportionate expense of the public fire protection, a very great additional burden should not be placed upon this class of consumers. Western Virginia Water & Electric Co., P. U. R. 1920 D. 409.

Super-Power Electric Systems

Co-operation of power units in the South Atlantic and in California, with possibilities of such a system in the North Atlantic districts.

States in the past have shown a tendency to wish to preserve their natural advantages for their own citizens. New Jersey, for instance, has a law forbidding other states from obtaining water supplies from watersheds within her area. At present, New York State is endeavoring to preserve for herself, as against federal control, all the water power available within her boundaries. This is believed by some to be selfish and short-sighted and a position that ultimately will be found to be untenable.

In expressing this opinion, Guy E. Tripp, chairman of the Westinghouse Electric & Manufacturing Company, has called attention to the southern super-power system, through which power generated in North and South Carolina, Georgia, Alabama and Tennessee is all tied up into one system, and predicts that the time will come when all of the Atlantic seaboard will thus pool their power facilities and that in time the Atlantic Coast system and that now existing on the Pacific Coast will grow towards each other until the entire country will be embraced in one vast super-power system.

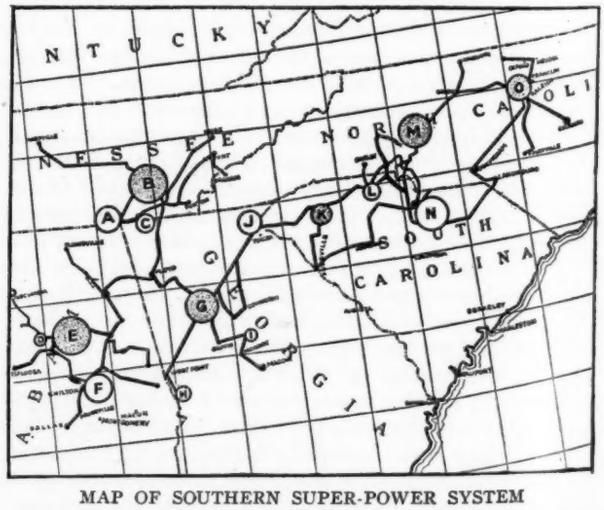
The southern super-power system to which he refers is shown by the accompanying illustration, in which the white circles indicate the principal generating stations, both hydraulic and steam; and the gray circles represent the chief centers from which the power is distributed to the near-by districts. The areas of the circles are proportional to the power generated or distributed at the several points. The heavy lines represent the connections between the several units. This system is over 600 miles long and covers the more important industrial areas of the states named, while extensions are already planned which will reach the remaining portions of these states and also Mississippi. The system is composed of seven independent but co-operating power companies.

All of the generating plants of the component companies pour all their energy into a common distributing network, which acts as a reservoir from which electricity can be drawn at any point for any purpose. This energy is obtained from hydro-electric plants, the exhaust gases of blast furnaces and refuse piles at coal mines. Water being the cheapest power, steam is not used until all of the available water power in all of the states is used to its limit.

An illustration of one of the advantages of this co-operation is shown by the experience last year of North and South Carolina. These states experienced a prolonged drought and consequent water-shortage, and, as a result, the hydro-electric stations in those states were unable to supply the states' demands. Had there been no arrangement for obtaining power from outside the state, many factories would have been shut down, railway service curtailed and general inconvenience and loss experienced. As it was, Alabama had more power than was needed in that state and contributed its surplus to the Carolinas. Alabama, in her turn, profited by being able to sell her surplus energy which would otherwise have gone to waste. Some other year the tables will undoubtedly be turned and the Carolinas will contribute their surplus energy to meet Alabama's deficiency.

Another illustration is reported on the Pacific Coast, where the whole state of California is covered by a system of independent members under unified management. Still another is seen in the combination of several large water power developments which are tied together by the electrification system of the Chicago, Milwaukee & St. Paul Railroad, which is said to be one of the principal reasons for its success.

Mr. Tripp then refers to the Northeastern part of the country and proposes a super-power system which would include the undeveloped power of the St. Lawrence river in both Canada and the United States, the power of Niagara Falls both developed and proposed, with other power centers in New York State, Massachusetts, Northern New Jersey, Philadelphia, Pittsburgh, and other smaller power centers. In this section millions of horsepower in the form of water are being allowed to run to waste while enormous sums are spent unnecessarily for coal for generating steam power, and still large areas of the state are unsupplied with electricity. Should all the power in this district be utilized and combined, there would result a power system unsurpassable anywhere in the world. In 1921 there was generated in this district 14,000,000,000 k. w.



MAP OF SOUTHERN SUPER-POWER SYSTEM

The white circles (A, C, D, F, H, I, J, L, N) represent the amount of power generated at points indicated; the gray circles (B, E, G, K, M, O) represent amount of power distributed to consumers from the points indicated, which are the principal distributing centers of the system. All circles are drawn to scale. The total amount of power supplied by this system is over two billion killowatt-hours a year, most of which is generated by water power.

h., while the water power of Niagara Falls and River is 27,000,000,000, that of the St. Lawrence 21,000,000,000, and the other existing powers total almost as much.

Waterproofing Concrete Stand-Pipe at Waltham

After sixteen years of use, increasing leakage necessitated elaborate repairs, using asphalt, felt, mortar and brick.

By George C. Brehm*

In 1906 the City of Waltham, Mass., constructed a reinforced concrete standpipe reservoir which was at that time the largest of its type in the country. The construction was of 1-2-4 concrete, the wall being reinforced with steel bars arranged in three rows up to twenty feet, two rows for the next seventeen feet and one row to the top, same being designed to keep the tensile stress within a 12,000 pound limit. The roof consists of a concrete slab three inches thick supported by steel trusses radiating from a central concrete-covered pipe column, which served also as an overflow.

This standpipe is one hundred feet in diameter, forty-three feet high, with a capacity of a little over two million gallons of water, and is situated in the western end of the city on a ledge knoll. The original cost of this reservoir was about $26,000. The specifications for its construction were prepared with the greatest care. The engineers in charge did everything possible to produce a concrete which would be absolutely water-tight. Every precaution known at the time was taken to insure against the slightest seepage. After extensive experiments, Medusa compound and lime were added to the concrete in prearranged quantities. After the concrete had cured and the forms been removed, all joints were thoroughly cleaned and scraped and the whole inside surface given an extensive brush coat of mortar treated with these same compounds. (This standpipe was described in Municipal Journal for Jan. 2, 1907, and July 22, 1915. Editor).

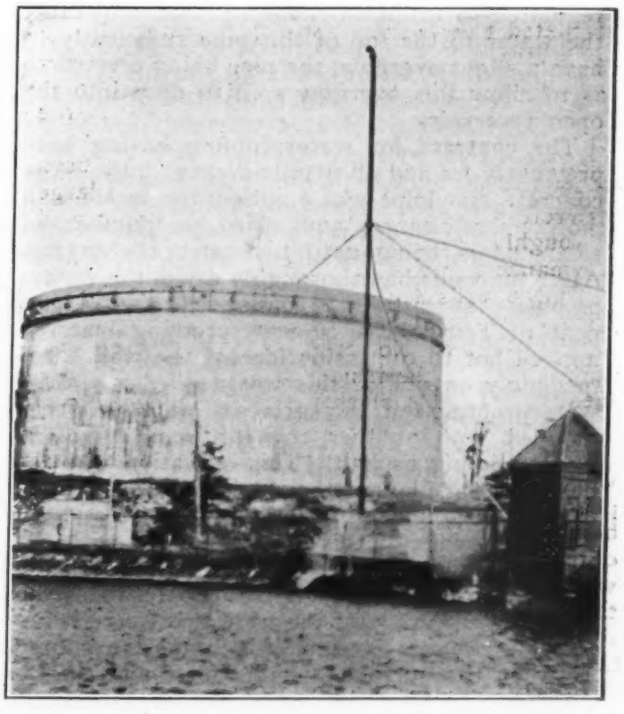
In spite of all these precautions at the time of construction, leakage developed after a few years. In 1914, an ill-advised attempt was made at water-proofing by the application of a coat of pitch to the inside wall. This amounted to very little and another attempt was made shortly after by the application of cement, using a cement gun on the outside. Neither of these methods proved satisfactory, the seepage continued and successive frost action caused several large areas of the outside wall to disintegrate, the surface breaking in several places to such an extent that the reinforcing rods became slightly exposed at several spots.

*City engineer and director of public works, Waltham, Mass.

The water level of the standpipe when full is 256 feet above sea level. The city also has, adjacent to this standpipe, an open reserve reservoir with a capacity of six million gallons, the elevation being, when filled, approximately 205 feet above sea level. Between the year 1914, when the first attempts were made at waterproofing, and the present, the water system of this city has been extended to the developed outlying sections of the city, and at the present time requires on elevation of not less than 235 feet at all times for the convenience and safety of the whole city, especially the outlying sections.

The problem therefore confronting the city officials was to keep sufficient pressure to insure the convenience and safety of the whole city with their water supply while a thorough and final job of waterproofing was being done. It was obvious that the reserve reservoir at an elevation of 205 feet would not insure the supply.

The writer, who is director of public works, conceived the idea of erecting an eight-inch pipe in the vicinity of this standpipe, tapping the twenty-four inch feeding main with a 24" x 8" Smith tapping sleeve and valve, and by keeping the pumps at the nearby pumping station continuously operating, maintaining a head of water at all times at sufficient height to insure the city supply. A wrought iron eight-inch pipe was therefore erected to a height of 276 feet above sea level, same being guyed for safety as shown in the accompanying photographs. The pumps at the pumping stations were then set in operation, the pumping continued for twenty-four hours per day, the speed of the pumps being



OPEN RESERVOIR IN FOREGROUND, CONCRETE STANDPIPE IN BACKGROUND, TEMPORARY STANDPIPE BETWEEN THE TWO.

VIEW OF TEMPORARY STANDPIPE FROM TOP OF CONCRETE STANDPIPE

regulated to maintain enough pressure to drive the water to the top of this pipe sufficiently to have a slight overflow, the pipe being erected so as to allow this overflow spill to drop into the open reservoir.

The contract for waterproofing having been previously let and all details arranged, the large concrete standpipe was emptied, the inside wall thoroughly cleaned and dried, a number of salamanders being used to hasten the drying. After the walls had thoroughly dried, the waterproofing was started. It consisted, first, of a mop coat of Texaco No. 56 waterproofing material applied hot to the inside face of the wall. Immediately outside of this was applied a coat of waterproofing felt, the surface of the same being mopped with another coat of Texaco No. 56 waterproofing asphalt. This operation was repeated for five layers, the outside layer, however, being of six-ounce saturated duck fabric, and the outside surface of this finally mopped with the waterproofing asphalt. Immediately following this, a four-inch brick core was constructed from the floor to the top of the wall, great care being taken to obtain a one-half-inch mortar course between the outside asphalt course and the inside face of the brick wall. All of this work, of course, was started at the bottom and built up the entire inside circumference of the wall in six-foot sections.

The work was started November 20th, 1922, in spite of the most inclement weather and was finally completed and the reservoir refilled on December 23rd. As the stagings on the side of the wall were taken down, the whole inside face of the brick core was thoroughly cleaned by washing.

It is of interest to note that all the materials used in this work had to be hauled to the very inaccessible point where the reservoir is located, raised to the top and lowered through a 4 x 4-foot hole made in the concrete roof. Instead of the usual steam or electric power for hoisting, the contractor used a medium sized tractor, rigging a boom derrick on the top of the reservoir, fastening the hoisting cable to the front of the tractor, which moved up and down the country road at the side of the standpipe, raising and lowering all the materials in a hoisting pan in this manner.

Simpson Brothers of Boston were the general contractors on the work, W. A. Murtfeldt Company of Boston, sub-contractor on the waterproofing, and M. F. Stankard of Waltham, subcontractor on the brick work. The engineer's estimate on the whole work was $16,500, while the low bid of the contractor for the whole work was $16,543. The materials used in the work were about as follows:

15 tons of Texaco No. 56 waterproofing asphalt, 150 rolls of felt, 550 bags of cement, 100 bags of lime, and 85,000 brick.

METHOD OF HOISTING WATERPROOFING MATERIAL INTO CONCRETE STANDPIPE

The reservoir has been refilled and every indication shows that a complete waterproofing job has been obtained and that no further seepage is possible. As soon as the weather permits, the city officials intend to touch up the outside wall with mortar where disintegration has taken place and will probably give the whole outside wall a thin stucco finish for the sake of appearance and protection. The reservoir is pronounced by experts now to be absolutely waterproof for all time.

Depth and Grading of Percolating Filters*

English and American views on the subject compared and conclusions from experiments carried on at Dorking, England.

The problem for solution in discussing the subject of percolating filters is how to get the best result from a given quantity of material; how should the material be arranged—in deep or in shallow filters? There were three possible views, all of which had their advocates.

(a) That the surface area should be as large as possible, i. e., the filters should be as shallow as possible down to a minimum of, say 2 ft. 6 in. This view was represented by the numerous fine filters of shallow depth found in Staffordshire and recommended strongly by Dr. Reid.

(b) That within reasonable limits the purification was governed by the cubic capacity, and was unaltered by the arrangement. This appeared to be the view taken by the Royal Commission on Sewage Disposal.

(c) The view held by the Massachusetts authorities that the most satisfactory depth of a filter was about 10 ft. or more, and a filter of this depth was capable of purifying a greater volume per cubic yard than was a shallower one.

Summarizing the works of Dr. Reid on fine filters, it was shown that in the results quoted purification was practically complete at a depth of 1ft., and that the remaining depth was practically without influence on the quality of the effluent.

It was to be noted that these results were obtained in a very weak septic tank effluent, oxygen absorbed 2.18, and suspended solids 3.8, and that at the rate of 200 gallons per square yard purification was to all intents and purposes complete at 1 ft. (cf. nitrates, oxygen absorbed, and transparency 24 in. over). Whether the lower part of the filter could be utilized by increasing the dose or in the case of a stronger sewage was not determined by those experiments. With a fine-grade filter it did not appear practicable to increase the dose sufficiently to utilize the lower part of the filter.

In quoting the work of the Royal Commission it was shown that in general with coarse filters the greater the depth the greater the purity of effluent when dosed at the same rate per square yard. Work done on these lines at Accrington (1897), Salford (1900), and Horfield was quoted.

These experiments, however, did not show whether it was better to arrange a given quantity of material in the form of a deep or of a shallow percolating filter, and the Royal Commission proceeded to investigate this at Horfield and Ilford. At Horfield they used two coarse clinker filters dosed at the same rate per cubic yard, and came to the conclusion that there was little to choose between the effluents; if anything, the deep filter effluent was slightly better, probably owing to irregularities of distribution being less pronounced with a deep filter.

Similiar experiments were carried out at Dorking, and they finally conclude:

(1) "That with the same dose per square yard the deeper the filter the better the effluent. This holds both for fine and coarse material, assuming good distribution and aeration.

(2) "For practical purposes and assuming good distribution, the same purification will be obtained from a given quantity of coarse material, whether it is arranged in the form of a deep or of a shallow percolating filter, if the volume of sewage liquid treated per cubic yard be the same in each case.

"Thus a filter 3 ft. deep, worked at the rate of x gallons per square yard per day, would give similiar results to a filter 6 ft. deep, worked at the rate of 2x gallons per square yard.

"In the absence of clogging, the balance would be slightly in favor of the deep filter, because the greater the depth the more errors of distibution would be neutalized. There must always be a limit of shallowness (say 3 ft.) beyond which it would be unwise to go, for however good the distribution might be, if a coarse filter were constructed very shallow, a considerable proportion of the sewage would pass through by 'short cuts.'

(3) "With regard to filters of fine material, if the liquid to be purified were absolutely free from suspended and colloidal solids, and if thorough aeration could be maintained, the statement just made for filters of coarse material might possibly hold good for filters of fine material also. In practice, however, these conditions can scarcely be maintained with large rates of flow, and we think that the greatest efficiency can be got out of a given quantity of fine material by arranging it in the form of a shallow filter rather than of a deep filter. But we are not in a position to make an exact quantitative statement as to the difference in efficiency of the two forms.

"It is probable that for the treatment of a strong sewage liquor the filter should not be quite so shallow as for a weak liquor, but the point has not been fully worked out.

(4) "The extent of the purification effected by a percolating filter varies with the average length of time taken by the sewage liquor to pass

*Notes of a paper delivered before the Yorkshire District of the Association of Managers of Sewage Disposal Works, Leeds, England, by W. J. Reid, deputy chief inspector to the West Riding Rivers Board.

through the filtering material, assuming that the proper aeration of the filter is maintained."

The experiments carried out at the Lawrence Experimental Station, Massachusetts, were then detailed.

The experiments were commenced in 1913, and an attempt was made to determine the rate at which four filters of different depths must be operated to obtain effluents of equal quality. The filters were of ¾ in. to 1½ in. broken stone, and were respectively 4 ft., 6 ft., 8 ft. and 10 ft. deep. They were fed with a settled sewage at such a rate that the nitrates in the effluent remained at about 1.5 parts in each case.

It will be noted that in this case the problem is attacked from a different standpoint; that is, instead of comparing the effluents produced at the same rates per cubic yard (or square yard) they manipulated the dosing until the effluents were the same, and then compared the rates of working.

The following table shows the results during 1914 and 1915, and the rates of dosing in British gallons:

1914.				
Filter	A	B	C	D
Depth, feet	4	6	8	10
Gallons—				
Sq. yd.	57	101	310	642
Cu. yd.	43	50	116	192
N. F. & S.	1.86	1.29	1.36	1.73
N. Alb.	.30	.29	.37	.39
Cl.	13.2	13.3	13.0	13.5
N'ic.	1.63	1.81	1.66	1.76
N'ous.	.006	.013	.013	.008
Ox. Abs.	1.89	1.79	2.17	2.38
Stab.	85	95	97	86
1915.				
Filter	A	B	C	D
Depth, feet	4	6	8	10
Gallons—				
Sq. yd.	80	138	304	605
Cu. yd.	60	69	114	181
N. F. & S.	1.23	1.22	1.18	1.12
N. Alb.	.24	.21	.27	.21
Cl.	9.1	9.3	9.5	8.6
N'ic.	1.03	1.07	1.00	1.26
N'ous.	.005	.016	.007	.003
Ox. Abs	1.89	1.62	1.84	1.80

The increase in rate of dose per cubic yard with the depth is remarkable.

It was stated that the Massachusetts authorities explained these results in terms of the hydraulic flow through the filter, showing by means of salt solutions that the times of appearance through the filters of a mixture of half salt solution and half sewage were 12, 18, 48 and 105 minutes respectively for the 4 ft., 6 ft., 8 ft., and 10 ft. filters, and that thus the time of contact for the deeper filter was longer in a much greater ratio than the various depths.

Further, they showed that when the rates were increased to give an equal time of contact, then the rates were also those which gave equal analytical results when dosed with sewage.

Mr. Reid pointed out that the results obtained were not in agreement with those obtained in England, and urged that experiments should be carried out on the Massachusetts lines, which method does not appear to have been used in that country.

Hudson River Toll Bridge

Work began in April on the bridge spanning the Hudson River between Bear Mountain and Anthony's Nose, the river span of which is said to be longer than that of any existing bridge, or 1,632 feet. The total length of the bridge between abutments will be 2,258 feet. The roadway will be 185 feet above the river and the two main towers will rise to a height of 350 feet above the foundations. The bridge will have a 38-foot roadway and a 5-foot sidewalk on each side. It will be suspended from two 17-inch cables, while the roadway will be supported directly by two stiffening trusses 30 feet deep. The bridge is estimated to have a capacity of more than 5,000 motor cars an hour. Wilson Fitch Smith is the chief engineer of the Bear Mountain Hudson River Bridge Company. Contracts for the construction were let in March and work on the approaches began in April and the steel companies have begun to fabricate the steel, of which more than 12,500 tons will be used.

Gasoline Tax in Tennessee

A tax levying two cents per gallon on gasoline and distillate sold in the State was passed and enacted by the Tennessee Legislature, March 15th, 1923. This tax is estimated to bring revenue of about one and one-half million dollars per year to be used for construction and maintenance of the State highway system. The State Legislature, after passing this bill, repealed the road tax which levied five cents per $100 on all property assessed by the State, which had been in force about four years, bringing in a revenue of approximately $700,000 per year.

Economy in Using Bulk Cement

In building 17 miles of concrete pavement in Black Hawk County, Iowa, the Northern States Contracting Company of St. Paul obtained its cement in bulk. The cement arrived in box cars which were spotted beside the platform at the cement warehouse. Four men shovelled the cement directly from the cars into two-wheel steel carts, which were wheeled by one man to a platform scale and weighed to correct any error in quantity. Batch trucks carrying aggregates for one 10-sack batch stopped at this platform, a steel plate hinged to the edge of the platform was dropped over the edge of the truck body to form a runway, and the 2-wheel carts dumped their loads of cement on top of the sand and stone. One of the dumpers then covered the cement with part of the sand in the truck so that it would not blow away while making the run to the mixer. No attempt was made to store the bulk cement, but the warehouse was kept filled with sack cement for emergencies, which occurred only occasionally.

Bulk cement was purchased for 5c. a barrel less than cement in the sacks, there were no sacks to check, count, bundle up and return and no money tied up in unreturned sacks. It was found that no more men were required than would have been needed for sack cement, and the trucks were loaded more quickly than if sacks had to be dumped onto the aggregate.

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CONTENTS

PROGRESS ON THE WANAQUE PROJECT. Illustrated 149
Cost of Paving in Charleston 153
Cost of Placing Stone on Road. By Rodman Wiley .. 153
MONTANA'S HIGHWAY POLICY 154
Nevada Gasoline Tax Law 155
Gasoline Tax in Virginia 155
Illinois Highways by Day Labor 155
Paving Prices in Centralia, Illinois 155
Maintaining Earth Roads 156
A Novelty in Highways 156
NEW WATER RATES IN ST. PAUL. By Jas. W. Routh 156
Sewerage in England 157
Fairmount Dam, Philadelphia 157
Erecting Tanks Downward 157
High-Class County Roads 157
Hydraulic Dam Construction with Electric Dredge ... 158
GROINED ARCHES 158
Street Openings in Plainfield, New Jersey 159
CURING A "SICK" SEWER SYSTEM. Illustrated. By Leon B. Reynolds 160
Philadelphia Sewer Specifications 162
Feeding a Six-Bag Paver 162
PRIVATE FIRE PROTECTION CHARGES AND METERING OF SPRINKLER SYSTEM. By John Simpson 163
SUPER-POWER ELECTRIC SYSTEMS. Illustrated. 166
WATERPROOFING CONCRETE STANDPIPE AT WALTHAM. Illustrated. By George C. Brehm 167
DEPTH AND GRADING OF PERCOLATING FILTERS 169
Hudson River Toll Bridge 170
Gasoline Tax in Tennessee 170
Economy in Using Bulk Cement 170
EDITORIAL NOTES 171
Water Connections and Paved Streets—Buy Construction Machinery Now—Public Health Boards and Finances.
Furnishing Equipment for Contractors 173
Using Local Road Material 173
WATER WORKS STATISTICS 174
STREET MAINS LAID IN 1922. Table 175
WATER PURIFICATION. Table 178
Refuse Utilization in England 184
Winding Roadway for Steep Street. Illustrated 184
Rubber Pavements in England 184

Water Connections and Paved Streets

As a general proposition, the fire underwriters and the majority of waterworks engineers do not recommend street mains for water supplies of less than 6 inches diameter, and yet the use of 2-inch pipe, we believe, is more than justified under certain conditions.

A number of cities have found so objectionable the digging-up of improved pavements for the laying of service connections that they require the water company or water department to carry connections to the curb opposite every lot, whether occupied or not, prior to the laying of a permanent pavement on the street in question. There are objections to this besides that of the idle capital represented by unused services, in addition to which there is no certainty that the pavement will not have to be dug up for repairing leaks in the services later on. If the main be laid between the curb and the property line, half of the services are removed from the roadway altogether, but the other half have to be carried entirely across it.

The chief reason for requiring a 6-inch main is to secure adequate supply to the fire hydrants. A 2-inch pipe would generally suffice to supply the domestic consumption of all of the houses on a single block. Why not, therefore, lay a 6-inch main inside the curb on one side of the street—just outside the property line would give the minimum length of service connections on this side and generally be further from tree roots than any other part of the sidewalk space—and carry a 2-inch line in a similar position on the other side of the street? The cost of the 2-inch line probably would not exceed that of carrying a ⅝-inch service line from the main on the other side of the street across to the location of the 2-inch line for each of the building lots on that side of the street; but even if the first cost should be somewhat greater, the cost of maintaining a service under the pavement is eliminated and all of the objectionable features connected with either laying dead services prior to paving the street, or cutting through the street for laying services as needed.

The above is not an entirely new idea, although it does not seem to have been adopted by many cities, but is suggested by a news item stating that Higginsville, Missouri, has adopted for one of its streets a plan somewhat similar, the construction in this city consisting of laying 2-in. pipe across the street at intervals of 300 feet to a point just behind the curb, where a 2-inch cross is placed; to which cross, by means of a tapped plug, house connections can be made.

Buy Construction Machinery Now

In a paper before the annual Michigan conference on highway engineering in February of this year, W. S. Cummings, highway engineer of Monroe county, stated a problem that is facing hundreds of other highway engineers when he said: "The problem is not altogether what shall we pay the men, but where shall we get them?

This condition among others has led us to do considerable experimental work in developing devices to suit our purpose." He then described equipment of various kinds which had been purchased, adapted or designed to save labor in various processes of road construction and maintenance.

During the past twelve months construction costs have increased 30%, that of several of the materials showing an increase of 50% and more. More startling and more serious, however, is the labor situation. Wages for labor in most sections of the country are from 50% to 100% higher than they were early in 1922 and, what is even more serious, the supply will apparently prove to be far from adequate. Already, although the season has barely started, contractors are finding difficulty in securing men at any price and highway construction has already been greatly interfered with in some sections by the labor scarcity.

A year ago the woods were full of would-be highway contractors, many of them apparently ignorant of the basic principles of estimating contract costs, and bids were cut to the point where profits reached or passed the vanishing point. Most of these have learned their lesson and, even with conditions the same as a year ago, bids would probably be higher. When we add to this the increase of from 30% to 50% and even more in the cost of materials and labor, and the probable scarcity of the latter with the increase which this will make in the cost of doing work, public works officials must be prepared for higher prices this year. Most of them are so prepared and it is probable that the amount done this year will not be greatly curtailed by such increase in prices as is reasonably accountable for by increased costs and wages.

Contractors, however, even though they may obtain fair prices sufficient to cover advance in costs, will still be confronted with the labor situation. To install an expensive plant, assemble a force of high-grade foremen and superintendents and then have the whole work halted by inability to obtain or retain sufficient labor to keep the equipment busy means loss in overhead and in interest and depreciation on plant that may easily eat up any prospective profits in a short time.

The high wages and scarcity and general unsatisfactoriness of labor during the past five or six years has resulted in the rapid development of mechanical appliances by which it is possible to replace a considerable percentage of the men formerly employed in highway construction. Given jobs of any considerable magnitude, mechanical graders and loaders, ditching machines, etc., will replace practically all pick-and-shovel men, one truck will replace a dozen mules with their drivers, the necessary bins and equipment for batch trucking of concrete aggregate will save all of the shovel and wheelbarrow gang ahead of the concrete mixer, while a finishing machine with one mechanic will replace several laborers behind the mixer.

The day is past when highways can be built successfully by a contractor whose only ability is getting work out of a gang of huskies. More than ever the highway contractor of the present and the future must be a man of business ability who can plan for each job that combination of equipment and methods requiring the minimum number of men to operate them that will most satisfactorily and economically produce the necessary results.

If anything approaching the amount of highway and other public work contemplated for this year is to be put through, contractors generally must provide themselves with the necessary equipment, and it seems certain that there will be an unprecedented demand for all kinds of labor-saving equipment and devices. We believe, therefore, that the contractor who is to be successful this year will supply himself with the necessary equipment in abundance, and will get it at once. Few of the manufacturers carry any large supply of equipment from year to year, and unless orders are placed at once, it is probable that deliveries cannot be made before the construction season is far advanced.

The suggestion in this to public works officials would appear to be that those who let their contracts earliest stand the most and perhaps the only chance of having them completed this year; and those will have the greatest advantage who let the work in contracts sufficiently large to warrant the contractors in providing themselves with the kind and amount of equipment necessary to meet successfully the anticipated scarcity of labor.

Public Health Boards and Finances

In an address before the Boston Society of Civil Engineers, M. N. Baker recently called attention to the demonstrated capacity of engineers to serve as health officers, citing Hiram F. Mills and Frederick P. Stearns in Massachusetts and the employment of engineers by most of the state and many local health departments.

One characteristic which the engineer in general possess much more abundantly than the physician is the ability to realize the limitations imposed by a fixed appropriation, discern the point of diminishing returns in each feature of a health program, and so apportion the expenditures among the several lines of endeavor as to obtain the maximum combined result in the form of public health. Judgment of this kind, available in its health officer, is of great value to a local health board, and should be appreciated and availed of. In this and in most other ideas conveyed by Mr. Baker in this address we agree heartily; but with one we must take issue.

"I hope I shall live to see the time," said he, "When our state health departments will not approve plans for water supply or sewage disposal until their engineers and other specialists have taken full cognizance of the entire sanitary and health needs of the municipality in question with a view to determining whether the

expenditure necessitated by the plans for approval would produce more and better results in terms of lives saved if the money was used for some other purpose. In other words, if state authorities are to be dictators over one or two classes of outlays for health and sanitation, let them cover the entire field."

In our opinion, the state board of health should NOT be a dictator, although some of them have assumed to be. We do not consider that how much a city pays for a water or sewerage system is any of its business, but only whether such system contributes to the health of the people. If it believes that a system could be obtained at less cost which would give equal health service, the board can and probably should so advise the city, but it should have no power to dictate in the matter. Its only function is to minister to the health of the community, not to its finances; to require the removal of conditions that threaten the health of the people of the state, but not to dictate the method to be employed or to prevent the trial of one that offers reasonable chances of success.

As indicating the possibilities of such dictation, cases can be cited where a state health board has prevented communities from installing water purification and sewage treatment plants which have been recommended by engineers with vastly wider experience and higher reputation than any one connected with the board as either member or advisor. If this power were general throughout the states and were exercised as at least two state boards have exercised it, progress in these branches of sanitary engineering would cease or could progress only along the lines that happened to be favored, for one reason or another, by those whom politics or other favoritism had placed for the time being at the head of an ultra-paternalistic health department.

After writing the above we find the same idea expressed by the editor of an English paper, "Municipal Engineering and the Sanitary Record," who, in discussing this part of Mr. Baker's paper says:

"We question his proposition that State health officials should have power to hold up plans of local water supply or for works of sewage disposal until the Department's engineers or other specialists are satisfied that the money could not be spent to better advantage on something else for the purpose of life. Some sort of inquiry would be necessary, local people would have to be heard, and a mass of discrepant material would confront the investigator. Would progress be possible if an official were delegated to sit in judgment upon such a mixture of local subjects, bias, and controversies?"

Furnishing Equipment for Contractors

In connection with the letting of contracts for constructing certain forest highways in New Mexico, the Bureau of Public Roads informs prospective bidders that it has on hand equipment useful for doing this work which can be used by contractors at rentals which are specified; and that in comparing the competitive bids, that one will be held to be in general the most favorable which requires the least cash payment by the Government—that is, the sums used in comparing the bids will be those obtained by deducting from the total bid the rental for the equipment which the contractor agrees to use.

This would appear to give a decided advantage to the contractor who was not provided with equipment of his own and might at first thought seem to open the way to giving the contracts to contractors of such little experience that they had not provided themselves with equipment suitable for the work.

In a letter to PUBLIC WORKS explaining the matter, however, E. S. Wheeler, district engineer of the Bureau of Public Roads for Arizona and New Mexico, states that conditions there are far different from those in the eastern part of the United States where there are numerous contracting concerns properly equipped for all kinds of construction. In the undeveloped southwest this is not the case and the Bureau feels that it is a duty to educate the contractors in the use of adequate equipment and that renting equipment to them is one of the means to this end. Moreover, contractors bidding on this work are not necessarily those who have never done any work of this kind before, although it is quite possible that such as they have done may have been of smaller magnitude. In addition, the district office exercises the prerogative of investigating the experience and ability of the contractor and his financial standing before recommendation for award is submitted.

Of the surplus war material which was turned over to the Bureau of Public Roads, 90% is distributed among the various state highway departments, but 10% is retained by the Bureau. It is considered to be the economical, efficient and business-like thing to save as much money to the Government as possible through the use of such equipment on day-labor projects or by renting it to contractors on work done on projects under the direction of the Bureau. The equipment is furnished to the contractors on a rental basis at prices that have been predetermined, and the Bureau also sells to the contractors explosives at a price that will reimburse the Government in a certain percentage of the original cost plus freight and handling. This price is made sufficiently reasonable to be attractive and to assist the Government in disposing of a large amount of explosives, but is not done for the purpose of competing with the local market.

Using Local Road Material

That part of Florida in the vicinity of Port St. Joseph is said to be entirely devoid of rock or gravel, or any other material ordinarily considered suitable for road surfacing. Recently, however, highways have been built of material found in the locality that have given good satisfaction. Even within the city itself a street has been surfaced with this material and is now nine years old without having depreciated materially.

The material used is a sediment from the bay

consisting of particles of shell, sea sand and a clay mud which, when dried, acts as an excellent cement. The cost of this road is said to average about $6,000 a mile. To ship any material such as stone or rock from other sections of the country would bring the cost of road construction to several times this amount.

In using this material a large steam shovel was run out into the shallow water and dug up the material from the bottom of the bay, which was then spread over the roadway and graded and permitted to dry thoroughly before being opened to traffic. The cementing mud is said to furnish a practically waterproof surface.

Water Works Statistics

Compiled from information furnished at our request by the superintendents of more than six hundred water works plants. Mains laid in 1922. Methods employed for purifying water.

In this issue we publish figures and other information compiled from questionnaires returned to us by the superintendents of more than 600 waterworks plants throughout the country. This compilation is arranged in two tables, one dealing with the street mains laid in the year 1922 and the other with methods of purification employed by the different waterworks plants.

The answers from which the first table was compiled were given in reply to the following questions: "What length did you lay in 1922 of castiron mains under 6 inches diameter?" "Of 6-inch, 8-inch, 10-inch and 12-inch diameter?" "Larger than 12-inch diameter?" "How much of this was centrifugal pipe?" "How much was 'universal'?" "How much with pre-made joints?" "How much steel main did you lay in 1922, 12-inch diameter or smaller?" "How much larger than 12-inch?" Information concerning steel pipe and kinds of pipe other than ordinary hub and spigot were comparatively few and are given in the last column headed "Other Kinds, and Remarks."

Apparently only three of the cities replying had used centrifugal pipe — Phoenix, Arizona; Cedar Rapids, Iowa, and Perry, Oklahoma. Mr. Blomquist, of Cedar Rapids, wrote that he got one car (2,000 feet) of it from the U. S. Cast Iron Pipe Company for trials last fall, and laid about 1,200 feet of it last year. "Our impression of it is that they still have it too brittle for successful use. A way of overcoming this may be found by changing the composition of iron used."

The water purification data compiled were given in reply to these questions: "In treating your water do you use sedimentation basins?" "Filters?" "What kind of filters?" "Do you chlorinate it?" "Do you soften it?" "Do you treat it in any other way?" "What was the cost of the purification plant?" "How many gallons was treated last year?" "What was the cost last year for labor at purification plant?" "What the cost of chemicals?" "What the cost of repairs?" "What the cost of power?" "What other cost of purification?" Apparently some of those replying interpreted the question concerning the cost of repairs to apply to the entire systems and not only to the water purification plant, and the cost of power to apply to the pumping as well as to water purification. We have nothing but the figures themselves as a basis for this assumption, and give the replies as they were returned on the questionnaire. Any explanations or supplementary information given in connection with the replies which could not conveniently be placed in the tables are given in the footnotes.

We have summarized the information concerning the methods of treatment employed by the various cities with the following results: Of all the plants reporting, 26.6% treat the water in sedimentation basins; 26.9% treat it in filters, 1.8% of these being pressure filters, 2.4% slow sand filters and 22.6% rapid sand filters. Five cities reported infiltration galleries, and two reported natural filters (sand or gravel in place). 41.6% of the plants reported chlorinating the water, four of them treating part of the water only in this way and nine of them only part of the time. Twenty-four plants reported softening the water, twelve used copper sulphate, four aerated, one used an iron removal process and one the excess lime process.

Quite a number of the cities which do not treat the water explained that it was obtained from sources where pollution was impossible, generally from deep wells. The names of these cities are not given in the table, as this would have increased the table to an excessive length.

A number of the plants are new and could furnish no operating data. These include Jasper, Ala., pressure filters installed in February; Blytheville, Ark., and Bristol, Conn. each just installing a chlorine plant; Orlando, Fla., will have a filter and chlorine plant ready in June; Johnson City, Ill., installed a rapid filter and chlorine plant last fall; Paris, Ill., has just started a rapid sand filter; Manhattan, Kans., has just completed a rapid sand, softening, iron removal, and chlorine plant; Cambridge, Mass., will have filters operating by June; Bay City, Mich., has a chlorine plant under construction; Benton Harbor, Mich., has just started a sand filter, chlorinating and softening plant; Yazoo City, Miss., has just installed a chlorinating plant, and Ambler, Penn., is installing one; Delaware, O., has just put in operation a sand filter, chlorinating and softening plant; Kittanning, Penn., put a mechanical filter and chlorinating plant in operation in January; North East, Penn., is installing a rapid sand filter and chlorinating plant; and Navasota, Tex., installed a chlorinating plant in April.

STREET MAINS LAID IN 1922

City	Plant municipal (M) or private (P)	Cast Iron Mains: Under 6"	6", 8", 10" & 12"	Over 12"	Other kinds, and remarks
Alabama:					Reports from 5 cities
Athens	M	.....	.....	.....	300′ steel mains 12″ or smaller
Jasper	P	1,400	3,500	.....	.....
Opelika	M	2,000	1,500	.....	400′ with pre-made joints
Arizona:					Reports from 4 cities
Douglas	M	17,500	.....	.....	.....
Phoenix	M	.....	4,546	.....	.....
Prescott	M	659	2,062	.....	.....
Arkansas:					Reports from 8 cities
Batesville	M	.....	750	.....	.....
Blytheville	P	1,000	.....	.....	All Universal. 300′ steel mains 12″ or smaller
Harrison	M	.....	135	.....	All Universal
Pine Bluff	P	20,000	6,000	.....	.....
Russellville	P	4,100	.....	.....	.....
California:					Reports from 9 cities
Anaheim	M	3,822	14,181	.....	All Universal. 15,000′ steel mains 12″ or smaller
Glendale	M	115,935	56,514	.....	30,573′ steel mains 12″ or smaller
Monrovia	M	1,200	.....	.....	.....
Oxnard	M	680	2,100	.....	.....
Red Bluff	M	.....	300	.....	.....
South Pasadena	M	2,000	.....	.....	.....
Visalia	P	3,000	350	.....	6,000′ steel mains 12″ or smaller
Watsonville	M	.....	.....	.....	3,000′ steel mains 12″ or smaller
Colorado:					Reports from 6 cities
Colorado Springs	M	1,700	4,000	.....	.....
Ft. Morgan	M	.....	2,000	.....	.....
Las Animas	M	250	.....	.....	.....
Longmont	M	631	.....	.....	485′ steel mains larger than 12″
Montrose	M	11,000	.....	.....	16,000′ steel mains 12″ or smaller
Connecticut:					Reports from 9 cities
Ansonia	P	.....	315	.....	.....
Bridgeport	P	600	16,794	.....	.....
Bristol	M	.....	1,312	.....	2,871′ of w. i. smaller than 6″
New Britain	M	192	15,913	.....	180′ Universal
Putnam	M	360	966	.....	.....
Southington	M	10	871	.....	775′ Universal. 3,016′ of 2″ w. i. and steel mains
Torrington	P	528	702	.....	.....
Willimantic	—	.....	1,500	.....	.....
Delaware:					Reports from 2 cities
Dover	M	2,500	.....	.....	.....
Florida:					Reports from 7 cities
De Land	M	700	.....	.....	2 mi. steel mains small than 12″
Lakeland	—	10,000	.....	.....	2,500′ Universal. 1½ mi. 2″ gal. w. i.
Orlando	M	400	2,700	5,270	.....
Georgia:					Reports from 6 cities
Bainbridge	M	12	.....	.....	.....
Carrollton	M	2,300	38,300	.....	18,000′ with pre-made joints
Cordele	M	.....	900	.....	2,000 of 2″ steel mains
Griffin	M	320	2,200	.....	900′ centrifugal
La Grange	M	10,000	2,600	.....	2,600′ with pre-made joints
Idaho:					Reports from 8 cities
Blackfoot	M	.....	.....	.....	1,000′ steel main 12″ or smaller
Kellogg	P	.....	.....	.....	460′ steel mains 12″ or smaller
Montpelier	M	.....	.....	.....	800′ steel mains 12″ or smaller
Twin Falls	M	4,000	.....	.....	.....
Illinois:					Reports from 31 cities
Bloomington	M	13,200	2,600	.....	Smaller sizes Universal
Bushnell	M	2,500	.....	.....	.....
Centralia	M	.....	1,000	12,600	.....
Cicero	M	.....	7,800	.....	All Universal
Decatur	M	.....	9,000	.....	.....
Elmhurst	M	5,000	9,600	.....	.....
Evanston	M	354	17,160	.....	.....
Geneva	M	7,900	2,600	.....	.....
Johnston	M	56,910	47,178	.....	.....
Moline	M	.....	32,444	.....	.....
Oak Park	M	.....	1,328	.....	.....
Peoria	—	.....	7,231	.....	.....
Pinckneyville	M	.....	1,400	.....	.....
Quincy	M	213	9,322	3,327	.....
Springfield	M	1,406	15,737	2,257	.....
Whitehall	M	11,000	.....	.....	All Universal
Indiana:					Reports from 31 cities
Alexandria	M	.....	.....	.....	1,000′ of 2″ & 3″ w. i.
Columbia	M	1,900	400	.....	.....
Decatur	M	463	1,218	.....	.....
Elkhart	P	2,436	1,512	.....	.....
Evansville	M	.....	20,880	.....	.....
Huntington	M	1,795	3,598	.....	.....
Jasper	M	6,360	.....	.....	.....
Lafayette	M	2,666	1,433	.....	.....
La Porte	M	.....	447	13,876	.....
Lebanon	M	1,800	600	.....	.....
Nappanee	P	336	.....	.....	Universal
Newcastle	—	800	250	.....	.....
No. Manchester	M	4,000	.....	.....	All Universal
Rensselaer	M	2,800	.....	.....	.....
Richmond	P	540	4,828	.....	.....
Shelbyville	P	.....	1,500	.....	All Universal. 1,500′ of steel main smaller than 12″
South Bend	M	.....	17,000	.....	.....
Valparaiso	P	.....	.....	.....	Wood pipe used exclusively
Vincennes	—	.....	360	.....	.....
Washington	P	.....	.....	.....	2,436′ steel mains 12″ or smaller
Iowa:					Reports from 29 cities
Burlington	P	1,170	4,098	.....	.....
Cedar Rapids	M	.....	26,905	13,867	.....
Charles City	M	2,600	2,600	.....	.....
Cherokee	M	2,300	320	.....	.....
Davenport	P	.....	18,500	.....	.....
Des Moines	M	.....	27,563	.....	375′ of 6″ hydrant connections
Dubuque	M	718	24,405	.....	.....
Ft. Dodge	M	.....	11,000	.....	.....
Fort Madison	P	.....	1,500	.....	.....
Hampton	M	6,000	.....	.....	.....
Knoxville	M	.....	350	.....	.....
Maquoketa	M	.....	600	.....	.....
Mason City	M	700	5,800	.....	.....
Muscatine	M	.....	2,640	7,920	.....
Nevada	M	600	.....	.....	.....
Newton	M	3,550	.....	.....	.....
Ottumwa	M	.....	18,000	.....	.....
Sioux City	M	48,366	13,956	110	.....
Washington	M	700	300	.....	.....
Winterset	—	650	.....	.....	All Universal
Kansas:					Reports from 16 cities
Atchison	P	.....	1,790	.....	2,500′ of w. i. mains ¾″ to 2″
Council Grove	M	2,600	.....	.....	.....
Dodge City	—	22,400	4,700	.....	.....
Fredonia	M	750	.....	.....	.....
Hays	M	5,000	2,000	.....	3,000′ steel mains 12″ or smaller
Hutchinson	P	.....	20,000	.....	.....

STREET MAINS LAID IN 1922—(Continued)

City	Plant municipal (M) or private (P)	Cast Iron Mains: Under 6″	6″, 8″, 10″ & 12″	Over 12″	Other kinds, and remarks
Kansas (Continued)					
Independence	M	2,600	.....	.....	.....
Junction City	M	54	500	.....	.....
Lawrence	M	27,785	43,484	2,300	All Universal
Manhattan	M	1,000	.....	.....	.....
Marysville	P	16,000	.....	.....	.....
Osawatomie	M	5,280	.....	.....	.....
Pittsburg	—	1,500	3,700	.....	.....
Kentucky:					Reports from 14 cities
Ashland	M	4,782	15,433	.....	5,427′ of w. i. main smaller than 12″
Bowling Green	M	.....	.....	.....	5,190′ steel main smaller than 12″
Covington	M	.....	14,000	.....	All Universal
Glasgow	P	.....	.....	.....	2 miles of steel main
Hopkinsville	P	268	887	.....	587′ with pre-made joints
Louisville	M	2,730	90,232	9,768	All Universal
Madisonville	—	1,000	.....	.....	.....
Paris	P	.....	500	.....	.....
Providence	M	1,200	.....	.....	All with pre-made joints
Louisiana:					Reports from 8 cities
Alexandria	M	.....	24,000	.....	.....
Baton Rouge	P	.....	7,100	.....	2,100′ was Universal. 20,000′ steel main 12″ or smaller
Minden	—	5,280	.....	.....	All Universal
New Orleans	M	16,072	90,131	14,500	.....
Rayne	M	.....	.....	.....	5,000′ steel main 12″ or smaller
Maine:					Reports from 6 cities
Calais	P	.....	200	.....	All Universal
Gardiner	M	400	700	.....	700′ with pre-made joints
Houlton	—	.....	568	.....	.....
Kittery	MP	.....	48	.....	Universal
Rockland and three other cities	P	.....	1,174	.....	4,277′ of 2″ w. i. pipe
Maryland:					Reports from 2 cities
Frostburg	M	400	.....	.....	.....
Massachusetts:					Reports from 44 cities
Adams	M	200	2,396	7,800	.....
Amesbury	M	3,710	320	.....	.....
Andover	—	.....	7,800	.....	.....
Athol	M	.....	4,964	.....	1,290′ was Universal
Attleboro	M	.....	2,196	.....	.....
Barnstable	P	2,616	.....	.....	2,616′ of steel mains 12″ or smaller
Belmont	M	.....	9,191	.....	.....
Brockton	M	.....	4,800	5,692	.....
Cambridge	M	359	4,631	.....	.....
Danvers	M	.....	11,033	77	.....
Falmouth	M	285	14,505	.....	2,500′ steel main 12″ or smaller
Fitchburg	M	.....	1,644	3,335	.....
Foxborough	M	100	2,200	.....	.....
Framingham	M	.....	24,772	.....	.....
Franklin	M	.....	2,500	.....	.....
Haverhill	M	964	10,580	.....	.....
Lexington	M	430	3,051	.....	.....
Malden	M	24	5,081	.....	.....
Mansfield	M	.....	10,800	.....	All Universal
Maynard	M	1,000	300	.....	.....
Milton	M	.....	6,069	.....	.....
New Bedford	M	98	25,765	12,071	.....
Newburyport	M	495	875	.....	.....
North Adams	M	400	4,480	.....	.....
Pittsfield	—	310	7,360	970	.....
Revere	M	.....	8,883	.....	300′ of 2″ galv.
Spencer	M	.....	970	.....	.....
Stoughton	M	.....	2,424	.....	.....
Swampscott	M	132	4,704	.....	.....
Taunton	M	.....	942	.....	.....
New Jersey (Continued)					
Newark	M	948	19,681	3,030	.....
Nutley	M	.....	2,745	.....	.....
Perth Amboy	M	.....	2,795	.....	.....
Phillipsburg	—	.....	200	.....	.....
Ridgewood	M	.....	9,700	.....	1,200′ with pre-made joints
Rockaway	M	1,400	.....	.....	.....
Somerville	P	140	2,876	.....	.....
South Amboy	M	450	.....	.....	All Universal
South River	M	500	1,000	.....	.....
Westfield	P	.....	6,000	.....	.....
Woodbury	M	.....	4,950	.....	All Universal
New York:					Reports from 30 cities
Baldwinsville	M	.....	400	.....	.....
Dansville	—	1,500	2,180	.....	480′ Universal
East Syracuse	M	1,100	.....	.....	.....
Elmira	M	713	7,302	.....	2,400′ Universal
Frankfort	M	.....	1,050	.....	950′ Universal, 100′ with pre-made joints
Geneva	M	.....	2,400	.....	.....
Jamestown	M	1,011	18,054	5,443	1,924′ w. i. pipe, smaller than 12″
Kingston	M	150	500	2,000	.....
Little Falls	M	.....	2,400	.....	.....
Lowville	M	.....	68	.....	.....
Malone	M	2,709	.....	.....	All Universal
Middletown	M	510	.....	.....	.....
Mohawk	M	33	.....	.....	.....
Mount Vernon	M	5	2,134	.....	.....
Norwich	P	.....	696	.....	.....
Nyack	M	350	640	.....	.....
Olean	M	5,000	800	.....	.....
Oswego	M	.....	4,896	.....	.....
Peekskill	M	.....	1,660	.....	.....
Perry	M	600	1,800	.....	.....
Sidney	M	408	216	.....	72′ Universal
Southampton	P	4,011	1,096	.....	3,500′ Universal
Syracuse	M	.....	26,734	31,000	26,734′ Universal
Waterford	M	.....	1,450	.....	.....
North Carolina:					Reports from 12 cities
Canton	M	400	7,000	.....	.....
Charlotte	M	3,000	75,350	.....	400′ with pre-made joints
Greensboro	M	.....	30,300	4,000	.....
Greenville	M	2,600	.....	.....	.....
Kinston	M	.....	14,600	.....	.....
Monroe	M	.....	1,600	.....	.....
Morehead	M	.....	3,000	.....	All Universal
Rocky Mount	M	.....	8,700	.....	3,000′ of 2″ galv.
Salisbury	M	.....	1,000	.....	10,000′ steel mains, 12″ or smaller
Statesville	—	.....	7,000	.....	.....
Washington	M	.....	.....	.....	500′ steel mains, 2″ and smaller
Wilmington	—	.....	9,400	.....	.....
North Dakota:					Report from 1 city
Fargo	M	.....	7,700	.....	.....
Ohio:					Reports from 28 cities
Barnesville	M	500	.....	.....	.....
Bellefontaine	M	1,500	.....	.....	All Universal
Bellevue	M	1,600	.....	.....	.....
Cambridge	—	500	.....	.....	.....
Cincinnati	M	5,453	27,213	.....	.....
Circleville	P	.....	1,100	.....	500′ of 2″ galv.
Conneaut	M	.....	1,200	.....	.....
Fremont	M	1,421	2,490	.....	.....
Kenmore	M	20,000	600	.....	4,000′ Universal
Lakewood	M	100	5,966	.....	.....
Lancaster	M	6,240	.....	.....	400′ of 2″ steel main
Lima	M	6,901	88,297	2,486	.....
Marinette	M	500	11,000	.....	.....
Medina	M	.....	1,110	.....	All Universal
Middletown	—	16,000	4,500	.....	.....
Mingo Junction	P	.....	.....	.....	500′ steel main, smaller than 12″
	M	600	.....	.....	600′ steel main, smaller than 12″

Waltham	M	336	3,545	.....	.....
Westfield	M	.....	3,025	.....	.....
Weymouth	M	.....	2,572	.....	.....
Winchendon	M	.....	1,000	.....	1,000′ of steel main 12″ or smaller
Michigan:					Reports from 26 cities
Alma	—	.....	.....	.....	5,000′ of 4″ and 6″ c. i.
Battle Creek	M	.....	9,330	.....	.....
Bay City	M	1,700	21,000	.....	12,000 steel mains 38″ diameter
Benton Harbor	M	.....	7,920	.....	.....
Big Rapids	M	1,000	.....	.....	.....
Coldwater	M	2,304	3,108	.....	.....
Detroit	M	660	17,180	.....	.....
Highland Park	M	1,356	4,170	.....	.....
Holland	M	108	2,943	.....	.....
Iron Mountain	—	.....	1,500	.....	.....
Ironwood	M	2,548	22,228	.....	.....
Jackson	M	.....	5,280	.....	.....
Ludington	M	.....	3,500	.....	.....
Mt. Clemens	M	19,000	.....	.....	.....
Mt. Pleasant	M	2,640	.....	.....	.....
St. Louis	—	6,300	1,275	.....	All Universal
South Haven	M	1,299	1,531	.....	.....
Traverse City	M	.....	1,800	.....	.....
Minnesota:					Reports from 16 cities
Alexandria	M	1,545	3,000	.....	All Universal
Bemidji	M	178	220	.....	All Universal
Duluth	—	.....	28,751	.....	.....
Hutchinson	M	4,000	2,000	.....	.....
Minneapolis	M	.....	76,564	2,722	.....
Moorhead	M	.....	2,000	.....	.....
Northfield	M	1,200	.....	.....	.....
Owatonna	M	200	3,500	.....	.....
Rochester	M	4,160	7,024	.....	.....
Two Harbors	M	750	.....	.....	.....
Waseca	M	8,686	.....	.....	.....
W. Minneapolis	M	4,968	.....	.....	All Universal
Mississippi:					Reports from 8 cities
Charleston	M	1,000	.....	.....	All Universal
Greenville	M	5,000	600	.....	2,000′ steel mains, 1½″ and 2″
Jackson	M	60	13,500	.....	.....
Missouri:					Reports from 9 cities
Kirksville	M	6,000	.....	.....	2,000′ steel mains, 12″ or smaller
Moberly	M	1,800	1,200	.....	.....
St. Louis	M	752	16,509	511	.....
Trenton	M	2,500	.....	.....	.....
Montana:					Reports from 3 cities
Bozeman	M	106	1,340	.....	600′ with pre-made joints
Kalispell	M	.....	760	.....	.....
Missoula	P	.....	.....	.....	300′ steel mains, 12″ or smaller
Nebraska:					Reports from 8 cities
Blair	—	1,000	.....	.....	All Universal
Chadron	M	4,700	510	.....	All Universal
Fairbury	—	28	12	.....	.....
Fremont	M	.....	6,247	.....	.....
Hastings	M	4,700	.....	.....	.....
Holdrege	M	5,400	1,410	.....	All Universal
Nebraska City	P	7,900	.....	.....	All Universal
Plattsmouth	—	.....	4,000	.....	.....
New Hampshire:					Reports from 4 cities
Lebanon	M	750	970	.....	All Universal
Manchester	M	458	15,206	5,727	.....
Newport	M	.....	350	.....	.....
New Jersey:					Reports from 22 cities
Bordentown	M	400	.....	.....	.....
Bridgeton	M	.....	3,900	.....	.....
Freehold	M	600	400	.....	.....
Glen Ridge	M	.....	300	.....	.....
Hawthorne	M	.....	5,000	.....	1,000′ Universal
Irvington	P	.....	10,577	.....	.....
Milltown	M	.....	108	.....	All Universal
Middletown	—	16,000	4,500	.....	.....
Mingo Junction	P	.....	.....	.....	500′ steel main, smaller than 12″
Montpelier	M	3,600	.....	.....	600′ steel main, smaller than 12″
Niles	M	.....	2,000	5,900	.....
Portsmouth	M	.....	23,204	.....	.....
Urbana	M	276	.....	.....	240′ of 1″ steel main
Willoughby	M	.....	6,000	.....	.....
Youngstown	P	.....	4,109	.....	.....
Oklahoma:					Reports from 7 cities
Ada	M	800	7,000	.....	.....
Perry	M	4,722	2,000	.....	10,000′ steel main, 12″ or smaller
Stillwater	M	2,150	3,250	.....	.....
Oregon:					Reports from 3 cities
Portland	M	97,648	49,452	216	.....
Pennsylvania:					Reports from 45 cities
Allentown	M	.....	7,475	.....	.....
Ambler	P	2,700	1,788	.....	.....
Blairsville	M	600	650	.....	.....
Bradford	M	100	950	.....	.....
Brookville	M	800	400	.....	.....
Catasauqua	—	300	.....	.....	200′ steel main less than 12″
Chambersburg	M	600	2,300	.....	.....
Connellsville	P	.....	2,000	.....	3,000′ steel main smaller than 12″
Danville	M	350	.....	.....	.....
Grove City	M	1,100	5	.....	Use leadite for joints
Hamburg	P	750	700	.....	.....
Hellertown	M	200	.....	.....	.....
Huntingdon	M	1,000	.....	.....	.....
Indiana	—	2,113	57	.....	.....
Kane	P	475	.....	.....	.....
Kittanning	P	.....	810	200	.....
Lancaster	M	1,280	10,059	804	550′ Universal, 6,000 with pre-made joints
Lebanon	—	1,200	7,800	.....	.....
Lehighton	P	3,300	.....	.....	.....
McDonald	P	400	300	.....	.....
Mechanicsburg	P	10,000	.....	.....	10,000′ steel main smaller than 12″
Media	M	1,200	.....	.....	All pre-made joints (McWayne)
Meyersdale	P	1,200	350	.....	525′ of 2″ steel main
Minersville	P	.....	1,909	.....	.....
Nazareth	P	800	1,500	.....	1,100′ Universal, 1,100′ with pre-made joints
North East	M	500	.....	.....	.....
Punxsutawney	—	1,200	900	.....	.....
Reynoldsville	M	1,740	.....	.....	90′ Universal
Ridgway	M	200	.....	.....	.....
Sayre	P	600	400	.....	.....
Somerset	M	.....	400	.....	.....
Stroudsburg	P	.....	3,000	.....	.....
Titusville	M	1,000	.....	.....	.....
Tyrone	P	1,215	.....	.....	.....
Rhode Island:					Reports from 3 cities
East Providence	P	1,544	720	.....	1,142′ of 2″ steel mains
Pawtucket	M	232	21,129	745	.....
Woonsocket	M	.....	7,959	.....	.....
South Carolina:					Reports from 10 cities
Charleston	M	.....	35,860	13,960	All cast iron cement lined
Cheraw	M	.....	.....	.....	1 mile galv. main
Chester	M	1,240	.....	.....	.....
Florence	M	3,000	22,000	.....	.....
Spartanburg	M	16,000	34,300	.....	.....
Sumter	M	3,000	1,400	.....	.....
South Dakota:					Reports from 2 cities
Rapid City	M	.....	2,935	.....	.....
Tennessee:					Reports from 12 cities
Covington	—	1,000	.....	.....	.....
Dyersburg	M	.....	2,250	.....	2,500′ of steel main smaller than 12″
Humboldt	M	3,000	.....	.....	All Universal

STREET MAINS LAID IN 1922—(Continued)

City	Plant municipal (M) or private (P)	Cast Iron Mains: Under 6″	6″, 8″, 10″ & 12″	Over 12″	Other kinds, and remarks
Tennessee (Continued)					
Jackson	M	.....	3,000	.....	.....
Maryville	M	1,200	200	.....	.....
Murfreesboro	M	400	6,500	.....	.....
Shelbyville	P	.....	.....	.....	3 miles steel mains smaller than 12″
Texas:					Reports from 16 cities
Childress	M	.....	57,000	354,000	.....
Cleburne	M	.....	.....	.....	2 miles steel main smaller than 12″
Del Rio	M	500	9,000	.....	.....
Greenville	M	.....	15,800	.....	.....
Longview	M	.....	4,000	.....	.....
Mart	—	3,000	.....	.....	.....
San Benito	P	7,750	9,951	.....	1,200′ steel mains 12″ or smaller
Stamford	M	.....	1,600	.....	.....
Weatherford	P	1,100	.....	.....	2,100′ steel main smaller than 12″
Utah:					Reports from 2 cities
Tooele	M	.....	.....	.....	790′ of 4″ wood pipe
Vermont:					Reports from 3 cities
Barre	M	253	185	117	117′ Universal
Newport	M	500	.....	.....	.....
Virginia:					
Richmond	M	1,418	48,863	12,826	.....
Washington:					Reports from 6 cities
Aberdeen	M	300	800	.....	4,000′ of 2″ steel mains. 150′ river crossing 6″ Universal. 650′ with pre-made joints
Auburn	M	5,000	2,200	.....	All Universal
Pullman	—	.....	5,000	.....	4,000′ Universal
Spokane	M	.....	4,648	.....	2,649′ of 12″ Kalamein; 11,233′ of 18″ to 30″ steel
West Virginia:					Reports from 4 cities
Elkins	M	2,500	3,450	.....	.....
Mannington	M	.....	.....	.....	1,000′ of 2″ and 250′ of 4″ steel mains
Wisconsin:					Reports from 32 cities
Ashland	P	12	804	.....	.....
Baraboo	M	.....	800	.....	.....
Beaver Dam	M	.....	350	.....	1,000′ galv. w. i.
Clintonville	M	475	1,300	.....	.....
Hartford	M	500	.....	.....	.....
Janesville	M	560	5,257	.....	.....
Jeffers	—	3,204	1,942	.....	All Universal
Kaukauna	M	364	850	.....	.....
Kenosha	M	260	19,194	1,910	.....
Ladysmith	M	3,314	5,424	.....	.....
Lake Geneva	—	8,000	.....	.....	.....
Lancaster	M	3,000	.....	.....	.....
Madison	M	414	8,838	.....	.....
Marinette	—	1,116	.....	.....	.....
Menasha	M	640	1,758	.....	.....
Milwaukee	M	.....	52,177	26,745	.....
Monroe	M	800	1,000	.....	.....
Neenah	—	2,000	600	.....	.....
Plymouth	M	800	.....	.....	.....
Racine	M	.....	3,608	72	.....
Reedsburg	—	200	1,403	.....	All Universal. 190′ of 10″ galv. w. i.
Shawano	M	1,050	.....	.....	.....
So. Milwaukee	M	.....	4,860	.....	.....
Stevens Point	—	.....	26,000	.....	8,000′ steel main smaller than 12″
Tomah	M	.....	.....	.....	1,000′ galv. w. i. 2″
Tomahawk	M	750	.....	.....	.....
Two Rivers	M	180	200	.....	.....
Washburn	P	486	.....	.....	.....
Watertown	M	1,486	7,047	.....	.....
Wyoming:					Reports from 2 cities
Evanston	M	500	.....	.....	800′ steel mains 12″ or smaller
Rock Springs	P	1,572	3,295	.....	.....

WATER PURIFICATION

City	Waterworks Municipal (M) Or Private (P)	Is Sedimentation Basin Used?	What Kind of Filters?	Is Water Chlorinated?	Is Water Softened?	Is It Treated In Any Other Way?	Cost of Purification Plant	Millions of Gallons Treated Last Year.	Cost of Labor at Plant.	Cost of Chemicals.	Cost of Repairs.	Cost of Power.	Other Cost of Purification.
Alabama:													
Athens	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Jasper	P	Yes	Pressure	.....	.....	.....	$35,000.00	Installed Feb 1923	.....	.....	.....	.....	.....
Opelika	M	Yes	Gravity sand	Yes	Yes	No	12,000.00	10	$1,500.00	$1,380.00	$80.00	$10,800.00	None
Talladega	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Arizona:													
Phoenix	M	No	Infiltration gallery	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Prescott	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Arkansas:													
Benton	M	Yes	Slow sand	Yes	No	No	.....	46	.....	75.00	None	.....	.....
Blytheville	P	No	None	Yes	No	No	600.00	Just installed	.....	.....	.....	.....	.....
Hot Springs Nat'l Park	P	No	Gravity sand	Yes	No	Cop. sulph. in lakes	.....	512.00	960.00	727.00	1,869.00	.....	$242.00
Pine Bluff	P	Yes	None	No	No	Hydrated lime to reduce CO_2 and iron	1,000.00	720	.....	10,000.00	None	None	None
Russellville	P	Yes	Rapid sand	No	No	.....	.....	.....	.....	.....	.....	.....	.....

California:													
Glendale	..	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Red Bluff	M	No	None	Part	No	No	600.00	250	.....	80.00	.....	.....	.....
So. Pasadena	M	Yes	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Watsonville	M	Yes	Jewell	Yes	No	No	400.00	30	250.00	200.00	100.00	.....	.....
Colorado:													
Longmont	M	No	None	Yes	No	No	800.00	747	31.50	160.00	6.97	None	88.79
Montrose	M	Yes	None	Yes	No	No	2,000.00	180	50.00	181.43	.....	.....	.....
Connecticut													
Ansonia	P	No	None	Yes	No	Cop. sulph.	9,250.00	729	906.00	425.00	356.00	50.00	.....
Bridgeport	P	No	None	Yes	No	Cop. sulph.	.....	20	.....	.....	.....	.....	.....
Bristol	M	No	None	Being installed	No	No	6,500.00	.....	.....	.....	.....	.....	.....
Putnam	M	Yes	Rapid sand	Yes	No	No	75,000.00	.....	959.00	.....	94.40	2,374.00	.....
Southington	M	No	None	Yes	No	No	4,700.00b	225	96.67	60.00	270.30	None	.....
Torrington	P	No	None	Yes	No	No	.....	.....	.....	.....	266.42	.....	.....
Willimantic	..	No	None	Yes	No	No	$1,000.00	547.5	None	84.00	None	.....	None
Florida													
Orlando	M	...	National	Yes	No	Lime	102,500.00	Being installed	.....	.....	.....	.....	.....
Georgia													
Carrollton	M	Yes	Greer and New York Jewell	Chloride of lime	No	...	20,000.00	6	1,400.00	750.00	None	$2,400.00	.....
La Grange	M	Yes	Am. Water Softener Company	Yes	No	...	35,000.00	360	.....	1,442.00	$571.00	2,584.00	.....
Idaho													
Kellogg	P	No	None	Yes	No	No	1,500.00c	.....	.....	96.00	75.00	20.00	.....
Lewiston	M	Yes	To be voted on May 22	Yes	No	No	.....	594.6	.....	308.00	170.00	.....	.....
Montpelier	M	Yes	None	Yes	No	No	2,000.00	220	420.00	72.00	75.00	300.00	None
Twin Falls	M	Yes	Pittsburgh Filter Co.	Yes	Yes	No	250,000.00	1,500	19,000.00	7,000.00	185.60	1,500.00	None
Illinois													
Centralia	M	No	None	Yes	No	No	.....	730	.....	Chlorine	.....	.....	.....
Decatur	M	Yes	Continental-Jewell	Yes	No	...	135,000.00	1,805.7	4,860.00	6,807.00	288.26	1,709.00	.....
Evanston	M	Yes	Rapid sand	Yes	No	...	250,000.00	2,509.2	10,000.00	4,500.00	175.00	150.00	.....
Johnston City	M	Yes	Rapid sand	Yes	No	Lime	325,000.00a	4.5	New plant	.....	.....	.....	.....
Lake Forest	M	Yes	Jewell and American	Yes	No	...	.....	300	.....	500.00	100.00	None	.....
Moline	M	Yes	Jewell	Yes	No	...	40,000.00	968	7,280.00	6,695.00	4,446.00	.....	.....
Mt. Carmel	M	Yes	Sand	Yes	No	...	25,000.00	365	3,500.00	2,000.00	1,600.00	14,000.00	1,800.00
Paris	M	Yes	Rapid sand	Yes	No	No	New plant	.....	.....	.....	.....	.....	.....
Quincy	M	Yes	Rapid sand	Yes	No	No	100,000.00	615	2,570.00	5,761.00	833.80	1,301.00	None
Springfield	M	No	None	Part	...	...	.....	.....	.....	.....	.....	.....	.....
Streator	P	Yes	Rapid sand	Yes	No	...	.....	700	1,156.05	.....	76.73	.....	.....
Indiana:													
Evansville	M	Yes	Norwood, rapid sand	Yes	No	...	269,601.00	3,183	11,367.00	14,194.00	1,769.00	.....	.....
Jasper	M	No	International, sand	Yes	No	No	10,000.00	61.2	450.00	280.00	10.00	2,260.00	None
Lebanon	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Richmond	P	No	None	Emergency	No	...	.....	.....	.....	.....	.....	.....	.....
Seymour	P	Yes	Mechanical	Yes	No	No	.....	300	.....	.....	.....	.....	.....
Shelbyville	P	No	None	Yes	No	No	.....	310	.....	59.53	.....	.....	.....
Valparaiso	P	Yes	Gravity, rapid sand	Yes	No	No	18,000.00	334	2,000.00d	1,160.00	150.00	3,700.00d	None
Vincennes	..	Yes	N.Y. Cont- Jewell Co.	Yes	No	...	.....	700	1,500.00	1,800.00	.....	.....	.....
Washington	P	Yes	Norwood, rapid sand	Yes	No	...	35,000.00	426.8	.....	3,000.00	250.00	.....	.....
Iowa:													
Atlantic	M	Yes	.....	Very limited	...	Aerate	.....	1.5	50.00	15.00	.....	.....	.....
Burlington	P	Yes	Norwood, grav. sand	Yes	No	No	88,411.00	1,018.3	4,818.00	9,955.00	.....	18,476.00	.....
Cedar Rapids	M	Yes	Gravity, rapid sand	Yes	No	No	50,000.00	1,399	5,407.00	5,242.00	1,060.00	60.00	.....
Cherokee	M	No	.....	Yes	No	No	800.00	6.8	None	56.00	25.00	None	None
Clarinda	M	Yes	Rapid sand	Yes	No	No	75,000.00	100	1,200.00	867.00	80.00	2,053.00	300.00
Davenport	P	Yes	Pressure	Yes	No	No	.....	1,500	.....	.....	.....	.....	.....
Des Moines	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Dubuque	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Fort Madison	P	Yes	Rapid sand	Yes	No	No	60,000.00	225	.....	2,000.00	.....	.....	.....
Keokuk	P	Yes	Pressure	Yes	No	...	.....	600	.....	.....	.....	.....	.....
Knoxville	M	No	Infiltration	...	...	...	.....	.....	.....	.....	.....	.....	.....
Muscatine	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Nevada	..	Yes	None	No	No	Aerate	.....	.....	.....	.....	.....	.....	.....
Newton	M	No	None	Yes	No	No	.....	90.3	.....	12.00	.....	.....	.....
Ottumwa	M	Yes	Rapid sand	Yes	No	No	38,420.00	825	2,400.00	15,000.00	.....	.....	.....
Sac City	M	...	.....	Yes	...	...	600.00	48	Very small	7.00	2.00	None	None
Kansas:													
Atchison	P	Yes	None	Yes	No	...	.....	500	448.00	2,896.00	.....	.....	.....
Council Grove	M	Yes	Open gravity	Yes	No	No	20,000.00	96.9	.....	492.00	192.00	581.00	25.00
Fredonia	M	Yes	Gravity rapid	Yes	No	...	40,000.00	100	1,200.00	900.00	New	725.00	None
Independence	M	Yes	Yes	Yes	No	...	.....	.....	.....	2,662.00	443.65	.....	150.00e

WATER PURIFICATION

City	Waterworks Municipal (M) Or Private (P)	Is Sedimentation Basin Used?	What Kind of Filters?	Is Water Chlorinated?	Is Water Softened?	Is It Treated In Any Other Way?	Cost of Purification Plant	Millions of Gallons Treated Last Year.	Cost of Labor at Plant.	Cost of Chemicals.	Cost of Repairs.	Cost of Power.	Other Cost of Purification.
Kansas (Continued)													
Junction City	M	No	None	Yes	No	No	.....	.....	.....	10.00	.....	.....	.....
Lawrence	M	Yes	Sand	Yes	Yes	No	.....	15	.....	.....	.....	.....	.....
Manhattan	M	Yes	Rapid sand	Emergency	Yes	Remove iron	66,000.00	Just completed	.....	.....	.....	.....	.....
Marysville	P	Yes	Pittsburg slow gravity feed	Yes	No	...	30,000.00	100	3,000.00	1,652.00f	.....	.....	.....
Osawatomie	M	Yes	N. Y. Cont. Jewell	Yes	No	Yes	.....	292	800.00	150.00	.....	.....	.....
Pittsburg	..	No	None	No	No	Aerate	.....	.....	.....	.....	.....	.....	.....
Topeka	..	Yes	Rapid sand	Yes	Yes	Yes	535,000.00	140	4,368.00	6,874.00	None	2,864.00	.....
Kentucky:													
Ashland	M	Yes	Rapid sand	Yes	No	No	24,207.00	487	184.74	3,596.00	297.53	None	121.19
Bowling Green	..	Yes	Roberts	Yes	Yes	...	.....	372.3	1,548.00	900.00	22.00	1,820.00	.....
Catlettsburg	P	Yes	None	Yes	No	...	.....	435	.....	2,500	.....	.....	1,874.00g
Covington	M	Yes	.....	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Frankfort	M	Yes	Slow sand	Yes	No	No	.....	2	.....	.....	.....	.....	.....
Glasgow	P	Yes	None	Yes	No	No	.....	.....	.....	315.00	35.00	.....	.....
Hopkinsville	P	Yes	None	Yes	No	...	11,500.00	190	500.00	1,800.00	150.00	1,500.00	None
Louisville	M	Yes	Rapid sand	Yes	...	...	1,394,883.00	13,122	15,615.00	.....	2,974.00	34,903.00	.....
Middlesborough	P	No	None	Yes	No	No	800.00	255.5	150.00	60.00	75.00	None	None
Morganfield	M	Yes	None	No	...	...	.....	.....	.....	.....	.....	.....	.....
Paris	P	Yes	Rapid sand	Yes	...	...	12,000.00	292	.....	1,000.00	1,000.00	50.00	.....
Louisiana:													
Lake Charles	P	No	None	Emergency	No	No	.....	.....	.....	.....	.....	.....	.....
New Orleans	M	Yes	Rapid gravity sand	Yes	Yes	...	000,000.00h	15,284	.....	65,000.00	.....	.....	1
Maine													
Gardiner	M	No	Slow sand	No	No	No	69,000.00	.....	1,496.00	.....	155.64	.....	.....
Houltan	..	No	.....	Yes	No	No	416.98	292.5	.....	241.40	7.50	.....	.....
Maryland													
Frostburg	M	No	None	Chlorinated lime, emergency	...	...	.....	10	200.00	60.40	None	.....	.....
Massachusetts													
Adams	M	Yes	None	No	No	No	.....	.....	.....	.....	.....	.....	.....
Athol	M	No	Rapid sand and slow sand	No	No	...	.....	300	.....	.....	.....	.....	.....
Attleboro	M	...	Natural gravel	No	No	No	.....	.....	.....	.....	.....	.....	.....
Cambridge	M	Yes	Yes	...	...	...	700,000.00+	Just completing	.....	.....	.....	.....	.....
Dalton	M	Yes	None	No	No	No	.....	.....	.....	.....	.....	.....	.....
Framingham	M	No	Filter galleries	Yes	No	No	500.00	413.8	.....	.....	125.00	.....	.....
Newburyport	M	...	Sand	No	No	No	.....	.....	.....	.....	.....	.....	.....
Westboro	M	Yes	Natural	No	No	No	Nothing	.....	.....	.....	.....	.....	.....
Michigan													
Battle Creek	M	...	.....	Yes	No	No	.....	1,329	.....	1,450.00	6,150.00	16,656.00	.....
Bay City	M	No	None	Yes	No	No	Under construction						
Benton Harbor	M	Yes	Sand	Yes	Yes	No	200,000.00	Just started					
Big Rapids	M	...		Yes	No	No	.....	90	.....	.....	.....	.....	.....
Highland Park	M	Yes	Gravity rapid sand	Yes	No	No	760,000.00	2,143.9	10,950.00	2,898.00	500.00	.....	None
Iron Mountain	..	No	None	Yes	No	No	1,000.00	286	.....	120.00	75.00	.....	None
Ironwood	M	No	None	Yes	No	No	.....	676	1,000.00	255.00	13.00	.....	.....
Jackson	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Ludington	M	No	None	Yes	No	No	350.00	450	Nothing	100.00	Nothing	25.00	None
Marine City	M	No	Nothing	Yes	No	No	.....	547	3,600.00	125.00	2,500.00	.....	.....
Mt. Pleasant	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Niles	M	No	None	Yes	...	...	800.00	240	None	84.00	100.00	.....	.....
Otsego	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
South Haven	M	No	None	Yes	No	No	.....	229.8	600.00	.....	.....	.....	.....
Traverse City	M	No	None	Yes	No	No	550.00	.....	.....	.....	.....	.....	.....
Wyandotte	M	Yes	Rapid sand	Both before and after filtration	No	...	300,000.00	900	9,000.00	3,125.00	300.00	7,517.00	.....

Minnesota													
Duluth		No	None	Yes	No	No	.....	3,248	None	833.45	None	None	None
Fairmont	M	..	.....	Yes	...	...	.....	.....	.....	.....	.....	.....	.....
Lake City	..	..	Sand	Lime hypo. in spring	...	...	.....	.....	.....	.....	.....	.....	.....
Minneapolis	M	Yes	Rapid sand	Yes	No	No	1,597,939.00	14,874	45,201.00	67,853.00	20,848.00k	3,819.00	1
Two Harbors	M	Yes	.....	Yes	No	...	.....	.....	114.72k	.....	.....	.....	.....
Mississippi:													
Jackson	M	Yes	N. Y. Cont.-Jewell	Yes	No	No	85,000.00	1,200	500.00	7,885.00	300.00	6,000.00	.....
Vicksburg	M	Yes	Rapid sand	Yes	No	No	.....	1,000	1,500.00	6,000.00	600.00	300.00	None
Yazoo City	..	No	None	Yes	No	No	.....	Just begun	.....	.....	.....	.....	.....
Missouri:													
Kirksville	M	Yes	Rapid sand	No	No	No	25,000.00	162	3,600.00	1,000.00	.....	4,500.00	.....
Macon	M	Yes	Pittsburgh	Yes	No	No	6,000.00	235.8	700.00	2,540.00	10.00	16,254.00	.....
Moberly	M	Yes	Rapid sand	Yes	No	No	57,869.00	208.1	.....	1,790.00m	.....	8,684.00	.....
St. Louis	M	Yes	Rapid sand	Yes	Yes	No	1,600,000.00	40,900	73,211.00	307,159.00	7,362.00	19,223.00	54,806.00
Trenton	M	Yes	Mechanical	No	No	...	.....	90	.....	800.00	1,500.00	25,000.00	.....
Montana:													
Bozeman	M	Yes	None	Part, summer only	No	No	500.00	195	.....	10.00	None	None	None
Missoula	P	No	None	Yes	No	No	550.00	36	50.00	150.00	25.00	.....	.....
Nebraska:													
Chadron	M	No	Infiltrat'n thro. grav.	...	...	No	.....	.....	.....	.....	.....	.....	.....
Nebraska City	P	Yes	None	Yes	No	...	.....	720	.....	3,000.00	2,100.00	26,000.00	.....
Plattsmouth	P	Yes	Rapid sand	No	No	No	.....	.....	.....	.....	.....	.....	.....
New Hampshire:													
Lebanon	M	No	N. Y. Cont.-Jewell	Yes	Yes	No	3,000.00	116.7	1,088.00	100.00	90.00	None	None
Walpole	P	No	Sand	No	No	No	.....	.....	.....	.....	.....	.....	.....
New Jersey:													
Bridgeton	M	..	Mechanical	Yes	No	...	75,000.00	700	2,500.00	3,800.00	None	None	None
Hightstown	M	No	Pressure	No	No	...	1,800.00	50	.....	600.00	None	.....	None
Newark	M	No	None	Yes	No	No	.....	16,008	.....	.....	.....	.....	.....
Nutley	M	Yes	Rapid sand	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Perth Amboy	M	No	Sand	...	...	...	.....	.....	.....	.....	.....	.....	.....
Phillipsburg	..	No	Sand	No	No	Cop. sulph.	.....	.....	.....	20.00	.....	.....	.....
Ridgewood	M	No	None	Yes	No	No	.....	294.5	.....	.....	.....	.....	.....
Rockaway	M	..	.....	Yes	No	No	1,000.00	15	200.00	80.00	72.00	.....	.....
Somerville	P	No	N. Y. Cont.-Jewell	Yes	No	...	.....	683	.....	1,844.00	822.13	.....	.....
South Amboy	M	No	None	Yes	No	No	12,500.00	302.2	.....	2,656.00	727.31	.....	None
New York:													
Canton	M	No	None	Yes	No	No	1,050.00	55	None	.....	.....	.....	.....
Dansville	..	..	.....	Yes	...	Cop. sulph.	2,100.00	450	250.00	27.00	25.00	.....	.....
East Syracuse	M	No	None	Yes	No	No	850.00	.....	240.00	36.00	50.00	None	None
Elmira	M	No	Slow sand	Yes	No	...	.....	1,638.5	10,026.00	4,656.00	3,139.00	.....	.....
Geneva	M	No	Slow sand	No	No	No	100,000.00	700	320.00	None	300.00	None	.....
Hudson	M	No	Slow sand	Yes	No	No	1,500.00n	912.5	1,536.00	175.00	250.00	None	None
Kingston	M	No	Rapid sand	Yes	No	...	.....	1,041.4	.....	.....	.....	.....	.....
Le Roy	M	Yes	Rapid sand	No	No	...	12,800.00	91	1,000.00	188.44	50.00	320.83	.....
Little Falls	M	No	Slow sand on part of supply	Yes	No	No	.....	1,117n	.....	.....	.....	.....	.....
Middletown	M	No	Grav., 5 mil. gal. cap., pressure, 3 mil. gal.	No	No	No	.....	1,231.5	5,000.00	1,012.00	284.09	528.46	.....
Mount Vernon	M	Yes	Rapid sand	Yes	No	No	.....	.....	p	.....	.....	.....	.....
Norwich	P	No	N. Y. Cont.-Jewell	Hypochlorite	No	No	33,000.00	650	1,500.00	3,300.00	500.00	None	.....
Nyack	M	No	Sand	Yes	No	No	.....	292	863.25	None	60.00	10,486.00	.....
Olean	M	Yes	Rapid sand	Yes	No	No	185,000.00	500	5,000.00	1,000.00	200.00	12,000.00	None
Oswego	M	No	None	Yes	No	No	2,000.00	1,744.6	.....	313.50	None	None	.....
Peekskill	M	Yes	Slow sand	Seldom	No	No	100,000.00	1,115.5	3,239.00	20.00	1,056.00	2,004.00	500.00
Perry	M	No	Slow sand	Yes	No	No	40,000.00	330	500.00	60.00	125.00	800.00	None
Sidney	M	Yes	Rapid sand	No	No	No	.....	.....	.....	.....	1,968.00	.....	500.00r
Syracuse	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Walton	P	No	N. Y. Cont.-Jewell	Yes	No	No	25,000.00	87	1,000.00	300.00	300.00	.....	.....
Waterford	M	Yes	N. Y. Cont.-Jewell	Yes	No	No	50,000.00	149	1,500.00	1,300.00	75.00	750.00	.....
Wellsville	M	Yes	Rapid sand	Slightly	No	Soda ash	42,000.00	190.9	2,661.00	829.73	17.65	6,849.00	.....
North Carolina:													
Canton	M	Yes	Pressure	Yes	No	No	600.00	109	.....	.....	.....	.....	.....
Charlotte	M	Yes	Rapid sand (Jackson)	Yes	No	No	.....	1,525.7	.....	.....	.....	.....	.....
Greensboro	M	Yes	Gravity rapid	Yes	No	No	.....	300	.....	.....	.....	.....	.....
Greenville	M	Yes	Gravity	Yes	No	No	100,000.00	.....	.....	.....	.....	.....	.....
Monroe	M	...	.....	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Rocky Mount	M	Yes	N. Y. Cont.-Jewell	Yes	No	No	.....	95	.....	1,600.00	.....	26,180.00	.....

WATER PURIFICATION

City	Waterworks Municipal (M) Or Private (P)	Is Sedimentation Basin Used?	What Kind of Filters?	Is Water Chlorinated?	Is Water Softened?	Is It Treated In Any Other Way?	Cost of Purification Plant	Millions of Gallons Treated Last Year.	Cost of Labor at Plant.	Cost of Chemicals.	Cost of Repairs.	Cost of Power.	Other Cost of Purification.
North Carolina (Continued)													
Salisbury	M	Yes	N. Y. Cont.-Jewell	Hypochlorite	No	No	216,850.00s	1,003.7	6,760.00s	2,929.00	502.00	.....	None
Statesville	..	Yes	Roberts	Yes	No	Cop. sulph.	38,000.00	24	240.00	.....	None	None	.....
Washington	M	Yes	Gravity	Yes	Yes	Yes	20,000.00	36.5	.....	800.00	100.00	.....	None
Wilmington	..	Yes	Gravity rapid sand	Yes	No	...	.....	1,095	5,460.00	14,000.00	1,100.00	.....	3,000.00t
North Dakota:													
Fargo	M	Yes	Rapid sand	Yes	Yes	...	250,000.00	800	.....	.....	.....	.....	.....
Ohio:													
Barnesville	M	Yes	Rapid sand	Yes	No	...	20,000.00	96	1,642.00	300.00	100.00	None	.....
Cambridge	..	Yes	Rapid sand	Yes	No	No	25,000.00	600	6,000.00	2,000.00	800.00	.....	800.00
Cincinnati	M	Yes	Rapid sand	Yes	No	No	.....	18,407.8	96,995.00	47,484.00	21,374.00	.....	.....
Circleville	P	...	Yes	No	No	No	Unknown	None	.....	.....	.....	.....	.....
Conneaut	M	Yes	Rapid sand	Yes	No	...	.....	.....	.....	.....	.....	.....	.....
Delaware	P	...	Sand	Yes	Yes	No	100,000.00	Just installed	.....	.....	.....	.....	.....
Kenmore	M	Yes	None	No	No	No	.....	.....	.....	.....	.....	.....	.....
Lima	M	Yes	Gravity rapid sand	Yes	No	No	125,000.00	1,682	7,956.00	8,500.00	1,260.00	4,364.00	None
Marietta	M	...	Rapid sand	Yes	No	No	57,000.00	800	.....	.....	.....	.....	.....
Medina	M	Yes	Rapid sand	Yes	Yes	Cop. sulph.	25,000.00	82.3	3,730.00	2,425.00	230.27	1,623.00	896.18u
Mingo Junction	P	No	None	Yes	No	No	350.00	98.4	.....	29.00	15.00	None	.....
Niles	M	Yes	Rapid sand	Yes	No	No	50,000.00	1,068.1	5,498.00	5,478.00	810.00	20,207.00	1,122.00t
Portsmouth	M	Yes	N. Y. Cont.-Jewell	Yes	...	...	140,000.00	1,500	4,200.00	7,250.00	1,350.00	200.00	5,700.00
Shelby	P	Yes	Rapid sand	No	No	No	50,000.00	300	2,000.00	.....	.....	3,000.00	.....
Willoughby	M	Yes	Sand	Yes	No	...	.....	.....	3,500.00	700.00	350.00	2,031.00	.....
Struthers	P	Yes	None	Yes	Yes	Excess lime	5,146.00	77.8	1,681.00	1,104.00	922.69	771.81	.....
Oklahoma:													
Collinsville	M	Yes	Pittsburgh Filter Co.	Yes	No	...	40,000.00	.....	None	150.00	10.00	None	None
Perry	M	Yes	Yes	Yes	No	...	100,000.00	.....	.....	.....	.....	.....	.....
Stillwater	M	Yes	Pittsburgh	Yes	...	...	.....	175	4,200.00	2,400.00	210.00	7,350.00	.....
Wagoner	M	No	Pittsburgh Filter Co.	Yes	No	...	.....	.....	.....	500.00	1,000.00	.....	25.00
Walters	M	...	.....	Yes	...	Cop. sulph.	.....	.....	.....	.....	.....	.....	.....
Oregon:													
The Dalles	M	No	None	Yes	No	No	1,000.00	1,460	1,080.00	193.42	None	None	None
Pennsylvania:													
Allentown	M	No	None	Yes	No	No	No plant	.....	.....	.....	.....	.....	.....
Ambler	P	Yes	None	Install'g plant	No	Cop. sulph.	.....	.....	.....	.....	.....	.....	.....
Braddock	M	Yes	None	Yes	No	Yes	.....	.....	.....	3,500.00	.....	.....	.....
Brookville	M	Yes	Rapid sand	Yes	No	...	.....	.....	.....	.....	.....	.....	.....
Chambersburg	M	No	None	Yes	...	...	200.00 -	950	875.00	30.00	5.00	.....	.....
Connellsville	P	Yes	Pressure	Yes	No	...	.....	807	.....	.....	.....	.....	.....
Danville	M	Yes	N. Y. Cont.-Jewell	Yes	...	...	.....	350	.....	1,060.00	.....	2,906.00	.....
Huntingdon	M	Yes	None	Yes	No	No	100.00	284.8	500.00	91.74	10.00	.....	50.00e
Indiana	..	Yes	Yes	Yes	No	...	.....	232.9	685.50	774.27	506.02	.....	.....
Jersey Shore	P	Yes	Rapid sand	Hypochlorite	No	...	32,000.00	540	2,500.00	250.00	1,800.00	.....	.....
Juniata	M	No	No	Warm weather	No	No	.....	.....	.....	50.00	.....	.....	.....
Kittanning	P	Yes	Gravity mechanical	Yes	No	No	125,000.00	500	875.00	1,500.00	.....	250.00	.....
Lancaster	M	Yes	Slow sand	Yes	No	No	225,000.00	2,870.9	.....	.....	.....	.....	.....
Lebanon	M	...	.....	Hypochlorite	No	Cop. sulph.	.....	700	.....	250.00	.....	.....	.....
McDonald	P	Yes	Scaife mechanical	Yes	No	...	15,443.00	131	500.00	356.72	None	None	None
Mechanicsburg	P	Yes	Pittsburgh	Yes	No	No	.....	.....	2,500.00	.....	.....	.....	.....
Media	M	Yes	Pressure	Yes	No	...	54,000.00	207.9	585.00	675.90	366.34	.....	.....
North East	M	No	Rapid sand	Yes	No	...	3,000.00	90	100.00	40.00	50.00	None	None
Parkersburg	P	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Punxsutawney	..	Yes	Pressure	Yes	No	...	.....	500	1,230.00	425.38	969.53	.....	.....
Reynoldsville	M	No	None	Yes	No	No	495.00	110	29.75	8.60	67.00	None	None
Ridgway	M	Yes	Rapid sand	Yes	No	No	100,000.00	460	4,500.00	300.00	1,000.00	6,500.00	.....
Sayre	P	No	Rapid sand	Yes	No	No	80,000.00	300	.....	.....	.....	.....	.....
Somerset	M	...	.....	When necess'ry	No	No	.....	.....	.....	.....	.....	.....	.....
Stroudsburg	P	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Tarentum	M	Yes	Pittsburgh Filter Co.	Yes	No	No	.....	250	5,000.00	1,200.00	1,892.00	4,200.00	None
Tyrone	P	No	None	Yes	No	No	2,648.00	1,000	561.85	356.00	None	None	None
West Newton	P	No	None	Hypochlorite	No	No	Home-made	54	.....	.....	.....	.....	.....

Rhode Island:													
East Providence..	P	Yes	N. Y. Cont.-Jewell	Yes	No	No	140,000.00	658.4	.....	5,140.00	160.00w	.....	.....
Pawtucket	M	No	None	Yes	No	No	.....	3,452	None	.....	.....	.....	.....
Woonsocket	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
South Carolina:													
Bennettsville	M	No	None	No	No	Soda ash	.....	75	300.00	300.00	.....	60.00	.....
Charleston	M	Yes	Gravity mechanical	Yes	Restore alkalinity with soda	Cop. sulph.	135,000.00x	2,313	.....	.....	.....	.....	.....
Cheraw	M	Yes	Am. W. Softener Co.	No	...	Soda ash	.....	50	3,000.00y	1,400.00	200.00	2,000.00	None
Chester	M	Yes	Roberts, wood tubs	Yes	When necessary	...	.....	.....	.....	.....	.....	.....	.....
Easley	M	Yes	Gravity sand	No	No	No	2,500.00	75	1,200.00	500.00	200.00	.....	.....
Spartanburg	M	Yes	Pittsburg slow sand	Yes	No	...	.....	600	.....	2,550.00	10,335.00k	8,350.00	None
Tennessee:													
Clarksville	M	Yes	Gravity	Yes	No	...	675.00	300	Nothing	900.00	Nothing	Very little	None
Dyersburg	M	Yes	Rapid sand	When river water used	No	Aeration	35,000.00	250	2,000.00	50.00	100.00	25.00	None
Fayetteville	M	...	.....	Yes	No	No	.....	137	150.00	.....	Nothing	.....	.....
Murfreesboro	M	No	Pressure	Yes	No	...	10,000.00	180	.....	.....	.....	.....	.....
Paris	M	Yes	.....	...	...	...	25,000.00	146	None	.....	.....	.....	300.00
Shelbyville	P	Yes	Slow sand	Yes	No	...	35,000.00	84	780.00	616.00	150.00	2,160.00	.....
Texas:													.....
Cameron	P	Yes	.....	Yes	No	No	17,500.00	15	500.00	600.00	.....	4,300.00	.....
Childress	M	Yes	Yes	Yes	No	No	30,000.00	None	.....	.....	.....	.....	None
Cleburne	M	No	None	Yes	No	No	.....	.....	.....	25.00	75.00	None	None
Eagle Pass.....	P	No	Infiltrat'n thro. grav.	Yes	No	No	Home-made	180	None	130.00	None	None	.....
Greenville	M	Yes	None	Yes	No	Cop. sulph.	None	.....	.....	.....	.....	.....	.....
Longview	M	Yes	Gravity	Yes	No	Yes	27,501.00	83	1,850.00	1,130.00	.....	.....	.....
Navasota	P	No	None	Yes	No	No	1,000.00	Just installed	.....	.....	.....	.....	.....
San Benito.....	P	Yes	None	Yes	No	No	.....	Just installed	.....	.....	.....	.....	.....
Stamford	M	No	None	Yes	...	...	.....	.....	.....	.....	.....	.....	.....
Weatherford	P	No	None	Yes	No	No	.....	55	None	25.00	45.00	None	None
Vermont:													
Barton	M	Yes	Brick	No	No	No	.....	.....	.....	.....	.....	.....	.....
Washington:													
Tacoma	M	No	None	Yes	No	No	7,000.00	15,330	500.00	4,971.00	931.00	.....	.....
West Virginia:													
Elkins	M	Yes	N. Y. Cont.-Jewell	Yes	No	...	85,000.00	8	200.00	300.00	.....	7,000.00	300.00
Martinsburg	M	No	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Sistersville	M	Yes	Rapid sand	Yes	No	No	40,000.00	250	2,725.00	640.00	600.00	1,900.00	None
Wisconsin:													
Ashland	P	No	Slow sand	Yes	No	No	80,000.00	512.7	420.00	75.00	85.17	None	959.23e
Kenosha	M	Yes	N. Y. Cont.-Jewell	Yes	No	Yes	88,398.00	1,760.3	6,489.00	6,101.00z	210.00	.....	340.00
Marinette	..	Yes	Jewell	Yes	No	...	.....	603.1	550.00	1,187.00	50.00	200.00	50.00e
Menasha	M	...	None	Yes	No	No	.....	.....	.....	.....	.....	.....	.....
Milwaukee	M	No	None	Yes	No	No	.....	23,646.9	66.56	2,788.00	.....	None	382.54
Racine	M	No	None	Yes	No	No	.....	2,156.4	174.71	373.32	None	None	None
Rhinelander	M	...	.....	Yes	...	...	.....	.....	.....	.....	.....	.....	.....
Shawano	M	...	Sand	Yes	...	...	.....	.....	.....	.....	.....	.....	.....
South Milwaukee.	M	Yes	Rapid sand	Yes	No	No	.....	300	.....	1,600.00	.....	.....	.....
Two Rivers.....	M	...	.....	Yes	No	No	.....	127.8	.....	58.41	.....	.....	.....
Washburn	P	...	.....	Yes	...	...	.....	.....	.....	.....	.....	.....	.....
Wyoming:													
Rock Springs....	P	Yes	Rapid sand	Yes	No	No	63,000.00	659.7	4,444.00	1,180.00	188.76	7,300.00	.....

a—Includes reservoir. b—Includes Venturi meter. c—Also $350 for building for chlorine plant. d—Estimated; records not separate from rest of water works. e—making analyses. f—Total cost of treating. g—Labor, maintenance, etc. h—Includes pumping plant and buildings. i—Exclusive of interest and depreciation, purification cost $9.12 per million gallons; including pumping and care of park and grounds, water cost $20.15 delivered into the distribution system. k—Include maintenance. l—Total cost $154,045. m—For 9 months, approximate. n—Chlorinating plant only. p—Water is purchased by city from New York Interurban Water Co., which purifies it. r—Patroling streams. s—Including raw water station and pipe line. t—For chemist and bacteriologist. u—$290.52 for laboratory, $447.71 for filters, $157.95 for chemical apparatus. v—Labor $60.91, chemist $1,275, operator $345. w—Material only. x—Not including buildings and sedimentation basin. y—Including superintendent's salary. z—Includes repairs and supplies.

Refuse Utilization in England

Utilization of municipal refuse is making considerable headway in England, some of the more important cities which have recently undertaken it being Sheffield, Birmingham, Stoke-on-Trent, Westminster, Oldham and Newark. Some of the newer features are the automatic loading of the screenings into canal boats and the provision of a pneumatic dust suction plant to handle all dust from screens and flues, providing destructors for the destruction of the material which is not salable, and utilizing the steam for generation of electricity for charging electric vehicles, driving the machinery around the plant and lighting the plant.

One of the Birmingham plants is estimated to cost about $450,000 and will probably be the most modern of the kind in the country. At this plant the refuse will first be screened, the screenings being sold as a low-grade fertilizer and removed by canal after being automatically loaded into canal boats, or by rail, whichever offers the lower rates. Material removed by the screens will be deposited on sorting belts from which articles of commercial value will be removed and the combustible material will be delivered by the belts to the incinerators. The clinker from the latter will be crushed and screened into different sizes and automatically discharged into canal boats or carts. Machinery will also be provided for treatment of by-products, for compressing tin into bundles, sorting and baling paper, etc.

Winding Roadway for Steep Street

Lombard street, San Francisco, between Hyde and Leavenworth, has a continuous grade of 27% and has been practically impassable for vehicles. The city has recently carried out the plans of the city engineer and reduced the roadway grade to 16% by winding it back and forth across the street, utilizing the full width of the roadway and a considerable part of that of the sidewalks. In order to carry out the construction of this roadway, it is necessary to build retaining walls on the downhill side of each diagonal course of the roadway. The roadway in banked at each turn.

While short lengths of street have been treated in this manner before, this is believed to be the first instance where the full length of a block has been developed in this way. The residents of the street are planning parking the areas between the curves of the roadway and installing ornamental electroliers. The sidewalk probably will be provided with vitrified brick steps alternating with inclined walks, while ornamental seats will be placed in the parked areas.

WINDING ROADWAY ON LOMBARD STREET, SAN FRANCISCO

Rubber Pavements in England

Experiments with rubber pavements are being carried out in Manchester by a firm which has been using rubber for floors and other purposes for the past forty-five or fifty years. Instead of making the pavement in blocks, large slabs of rubber two inches thick are to be used, each slab weighing about 600 pounds, so that the possibility of creeping or lifting which has been experienced in previous attempts will be reduced to a minimum. The surface is corrugated, giving the appearance of small blocks and supplying a safe foothold for horses. The slabs are reinforced at intervals with steel bars which keep them rigid. These slabs are placed on a concrete foundation and the joints are cemented with tar.

According to "Indian Engineering," an experiment has been made in Colombo with paving a road with a mixture of rubber, mexphalte and picaleum, which proved to be a failure; but another somewhat similar preparation was reported as very successful, this being said to consist of a mixture of pure bark and scrap rubber. It resembles tar and is delivered in solid form in barrels and is applied to the road by heating until liquid and spreading with brooms, after which fine gravel is sprinkled on the surface and lightly rolled.

Charleston, South Carolina, backfills trenches as well as repaving over them. The contractor who opens the street notifies the street department before 2:00 p. m. of the day when he is ready for backfilling. The city's backfilling gang is then sent and refills the trench, ramming in 6-inch to 8-inch layers. The foreman of the backfilling gang reports when this work is completed, giving the yardage of backfilling done. The party for whom the trench is filled is charged 80c. per cubic yard if the fill amounts to 15 cubic yards or less and 40c. if it amounts to more than that.